ZEXEL

FOREWORD

This manual has been prepared to assist service personnel in providing service and maintenance for the PFR·KD and PFR·MD type fuel injection pumps for small diesel engines.
Construction, operation, disassembly, reassembly, and adjustment procedures are explained here.

The illustrations, drawings and specifications in this manual are the most up-to-date at the time of publication.
Specifications and service procedures are subject to change without notice.

VORWORT

Dieses Heft soll dem Werkstattpersonal bei Instandsetzungs- und Wartungsarbeiten an den Kraftstoffeinspritzpumpen Typ PFR-KD und Typ PFR-MD für kleine Dieselmotoren helfen.
Aufbau, Arbeitsweise, Zerlegung, Zusammenbau und Einstellverfahren sind darin erklärt.

Die Abbildungen, Schemazeichnungen und technischen Daten in diesem Heft entsprachen zum Zeitpunkt seiner Veröffentlichung dem neuesten technischen Stand.
Änderungen der technischen Daten und Wartungsverfahren vorbehalten.

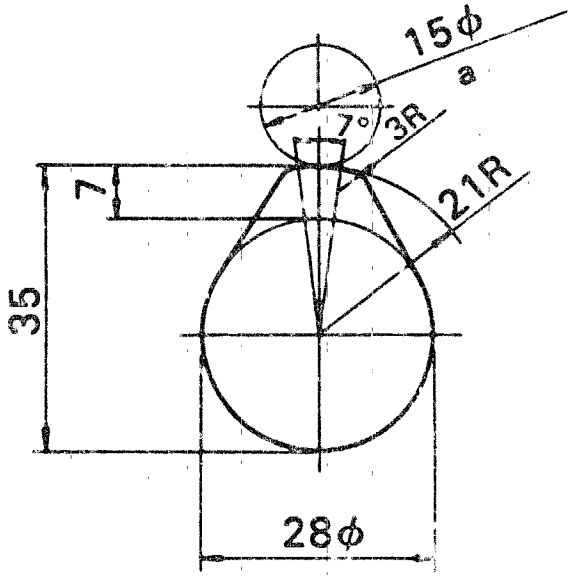


Fig. 1 a = Roller

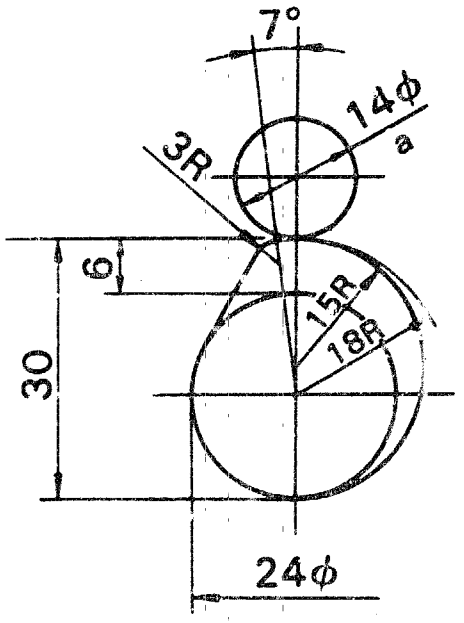


Fig. 2 a = Roller

FEATURES

PFR-KD Fuel Injection Pump

1. The PFR-KD pump is an improved PFR-K pump. This improved mocel can be applied to direct injection type engines. Since 1 to 5 cylinder types are available, small diesel engine requirements for a variety of applications can be satisfied.

2. Because of this pump's innovative design, the injection quantity can be adjusted by rotating the plunger barrel.

PFR-MD Fuel Injection Pump

The "PFR-MD" pump has been reduced in size and weight. This injection pump design utilizes the benefits of an aluminum die cast housing.

1. While aluminum is used to reduce the weight of the housing, all parts which are subjected to force and high-pressure fuel are made of steel. Therefore, the allowable in-pipe pressure can be high and the applicable plunger diameter large, even though the pump is small and lightweight.
2. The development of the two, three and four cylinder pumps enable a wide selection for various engines. Future-design will include one, five and six cylinder pumps.
3. Since no air vent is required for this new design, the variation in temperature and injection quantity has been minimized.
4. Another factor in today's market is replacement cost. Therefore, internal parts are available as single items, or as a complete plunger block assembly which consists of the plunger assembly, delivery valve, spring and holder.

	PFR·KD	PFR·MD
Number of cylinders	1, 2, 3, 4, 5	2, 3, 4
Applicable plunger diameter (ϕmm)	5.0 to 7.5 at every 0.5 step	4.0 to 6.0 at every 0.5 step
Standard retraction quantity of delivery valve (mm^3)	20, 25, 30, 35	20, 25, 30
Applicable injection quantity (mm^3/st)	approx. 5 to 70	approx. 3 to 30
Plunger stroke (mm)	7.0	6.0
Control rod travel (mm)	16	10
Maximum allowable speed (r.p.m) (using a standard Diesel Kiki cam)	2200 Fig. 1	2750 Fig. 2
Maximum allowable in-pipe pressure (kg/cm^2)	550	500
Recommended oil	Light oil, SAE 313a	
Pump weight (kg)	approx. 1 to 3.4	approx. 0.7 to 1.3

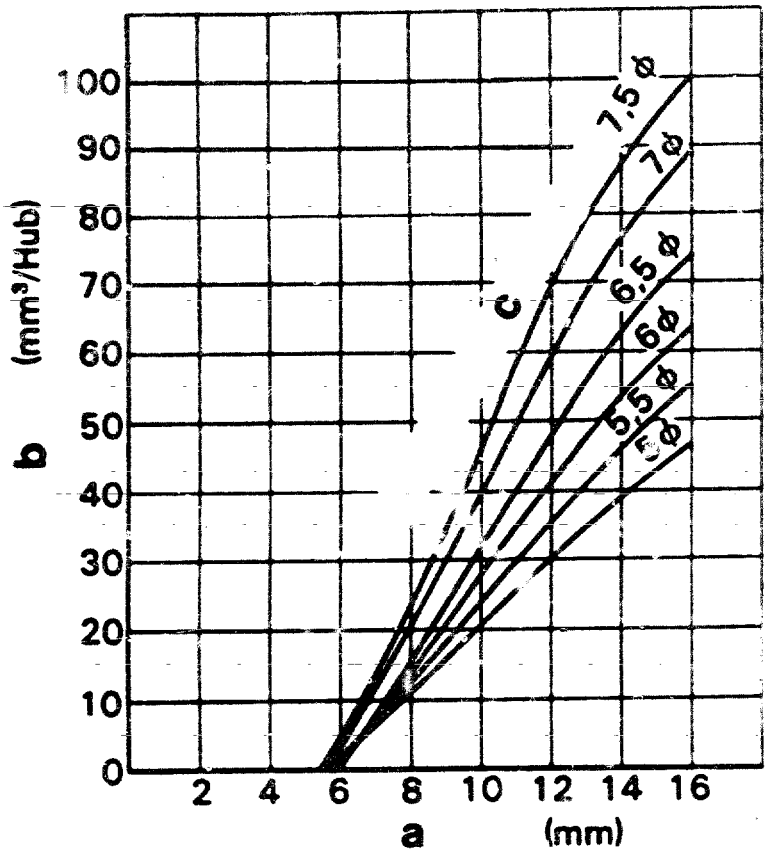


Fig. 3 Injection Quantity Characteristics PFR-KD

a = Control rack travel
b = Injection quantity (mm^3/stroke)
c = Plunger Diameter

Specifications:

Plunger lead:	12 mm
Retraction volume:	35 mm^3/st
Cam lift:	7 mm

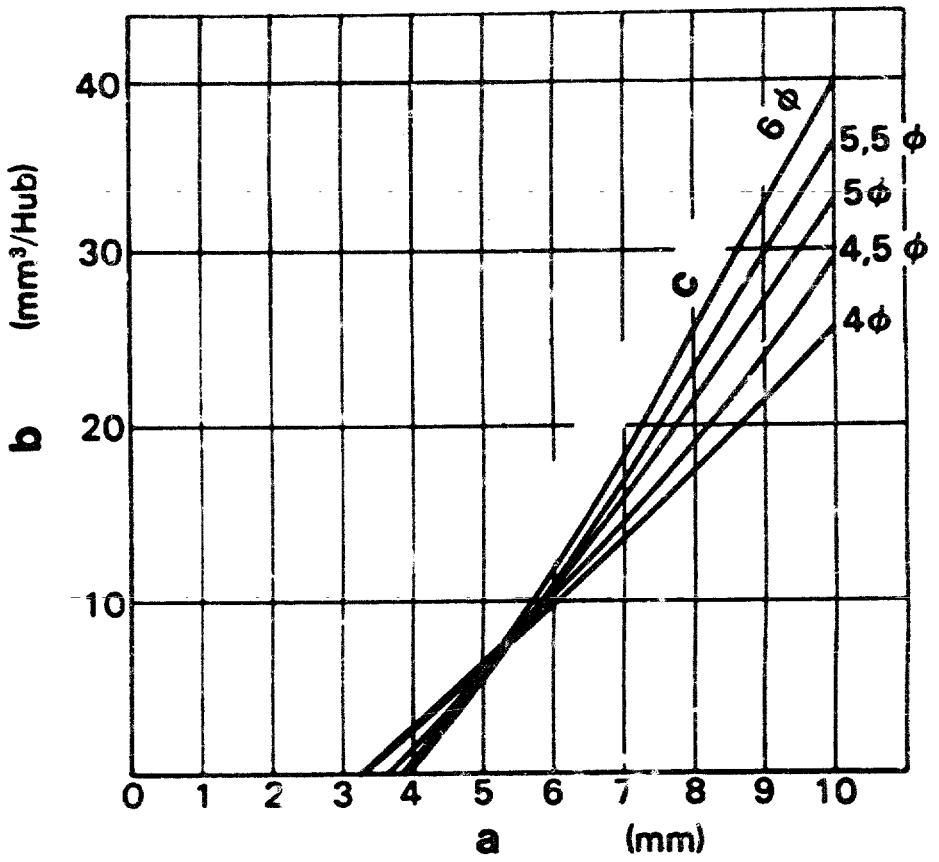


Fig. 4 Injection Quantity Characteristics PFR-MD

a = Control rack travel
b = Injection quantity (mm^3/stroke)
c = Plunger Diameter

Specifications:

Plunger lead:	12 mm
Retraction volume:	20 mm^3/st
Cam lift:	6 mm

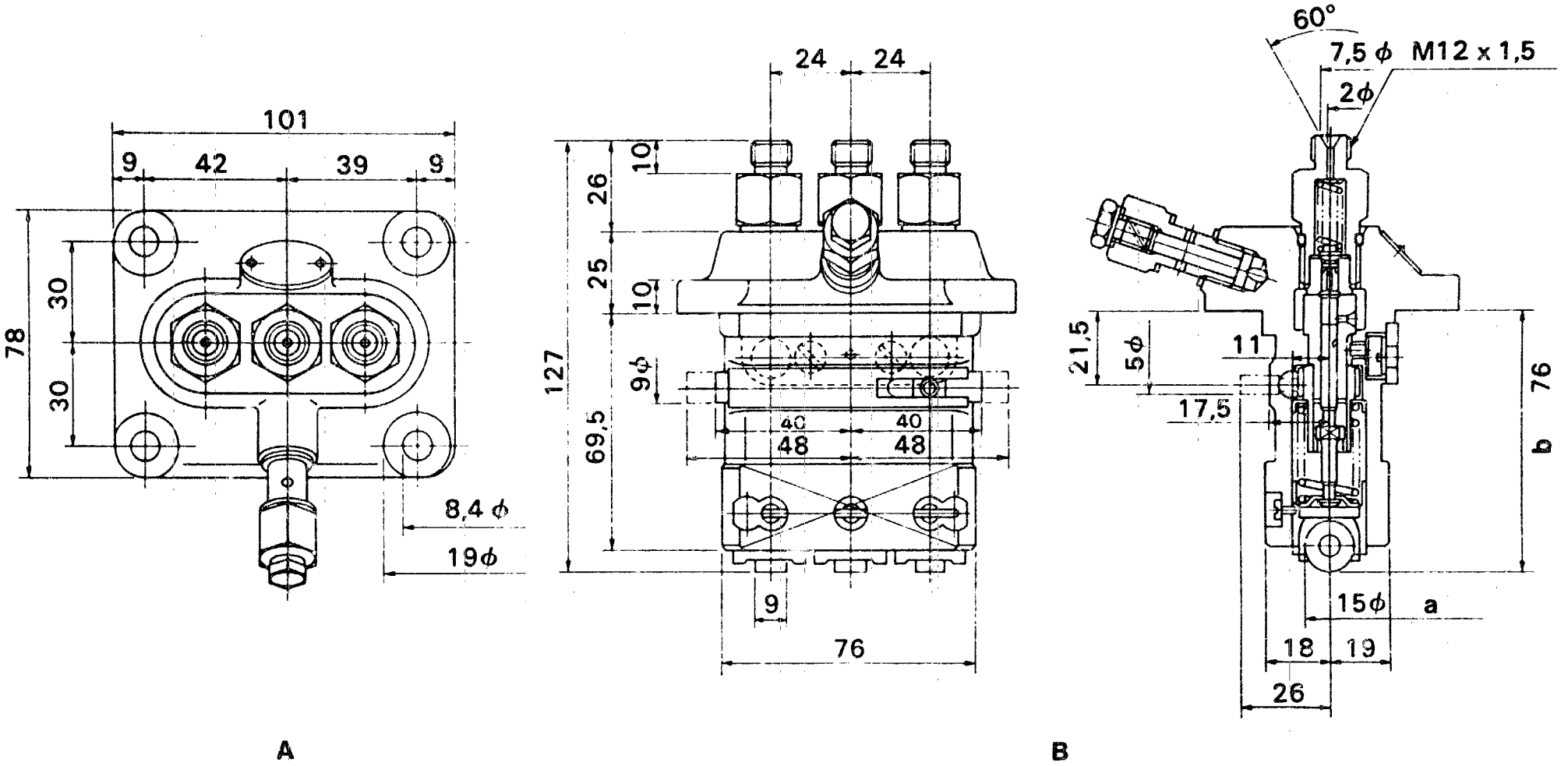


Fig. 5

PFR 3-KD pump

A = Top view
B = Side view

a = Roller
b = Suggested mounting dimension

Dimensions (the unit is mm)

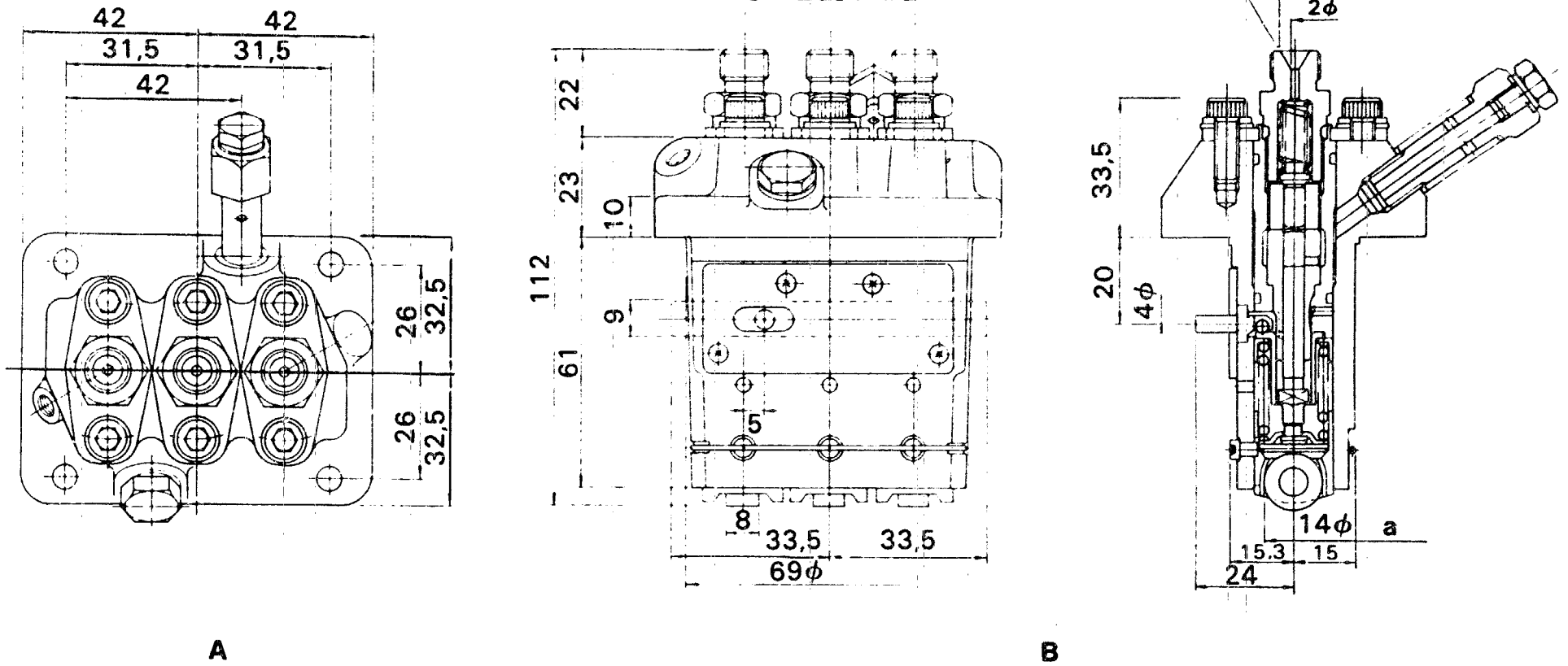


Fig. 6 PFR 3-MD pump

A = Top view
B = Side view

a = Roller

Dimensions (the unit is mm)

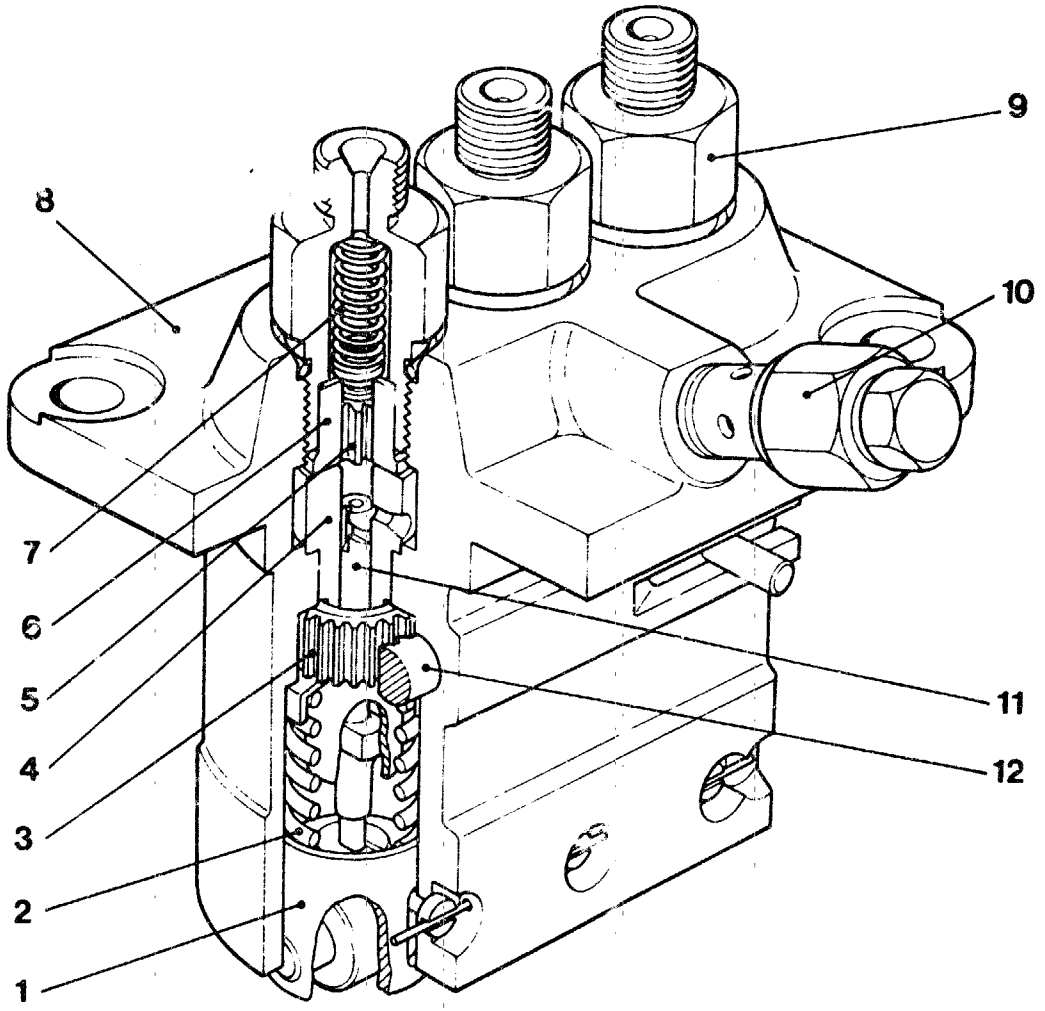


Fig. 7 PFR-KD pump Construction

1 = Tappet
2 = Plunger spring
3 = Control sleeve
4 = Plunger barrel
5 = Delivery valve
6 = Delivery valve seat
7 = Delivery valve spring
8 = Pump housing
9 = Delivery valve holder
10 = Eye bolt
11 = Plunger
12 = Control rack

CONSTRUCTION AND OPERATION

Operation

The PFR type injection pump is incorporated into the engine cylinder block. Unlike the PE type injection pump, it does not have a cam shaft but is driven by the engine cam shaft.

The plunger movement is constant, being raised by the tappet and returned by the plunger spring, through engine rotation. The fuel chamber of the pump housing is always filled with fuel oil, and the suction and discharge port of the plunger barrel opens on to this fuel chamber.

When the plunger descends, fuel oil is delivered to the plunger barrel. When the plunger reaches its lowest point, suction of fuel oil is completed. The plunger then ascends; the suction and discharge port of the plunger barrel is closed by the plunger, and the fuel oil pressure increases. Fuel oil is forced into the delivery valve, and is then delivered to the nozzle holder through the injection pipe. When the fuel oil pressure exceeds the nozzle spring set force, fuel oil is sprayed into the engine combustion chamber by the nozzle.

The plunger further ascends, and at the position where the plunger helix meets the suction and discharge port of the plunger barrel, delivery of fuel oil ends. (At the same time, the nozzle spraying ends.) The delivery valve is closed by the force of the delivery valve spring, so that fuel oil is no longer delivered, even though the plunger further ascends.

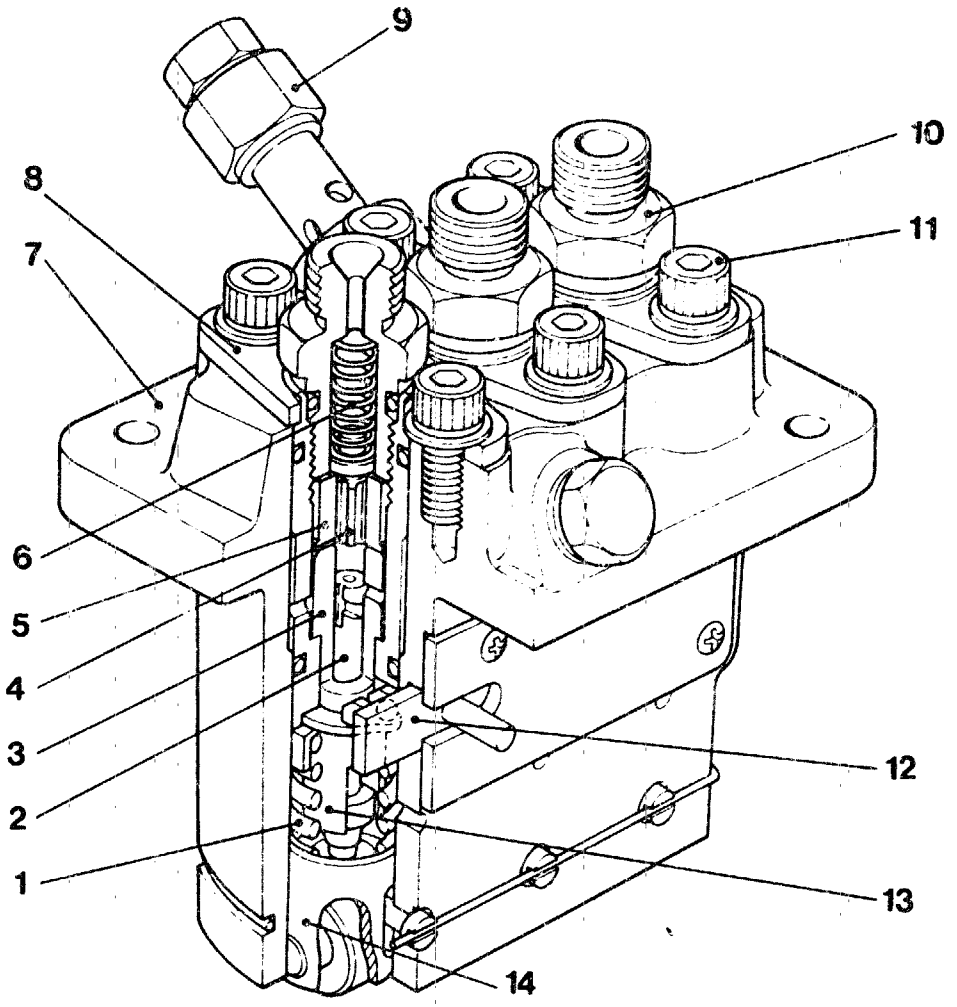


Fig. 8 PFR-MD pump Construction

1 = Plunger spring
2 = Plunger
3 = Plunger barrel
4 = Delivery valve
5 = Delivery valve seat
6 = Delivery valve spring
7 = Pump housing
8 = Sleeve flange
9 = Eye bolt
10 = Delivery valve holder
11 = Socket head bolt
12 = Control rod
13 = Control sleeve
14 = Tappet

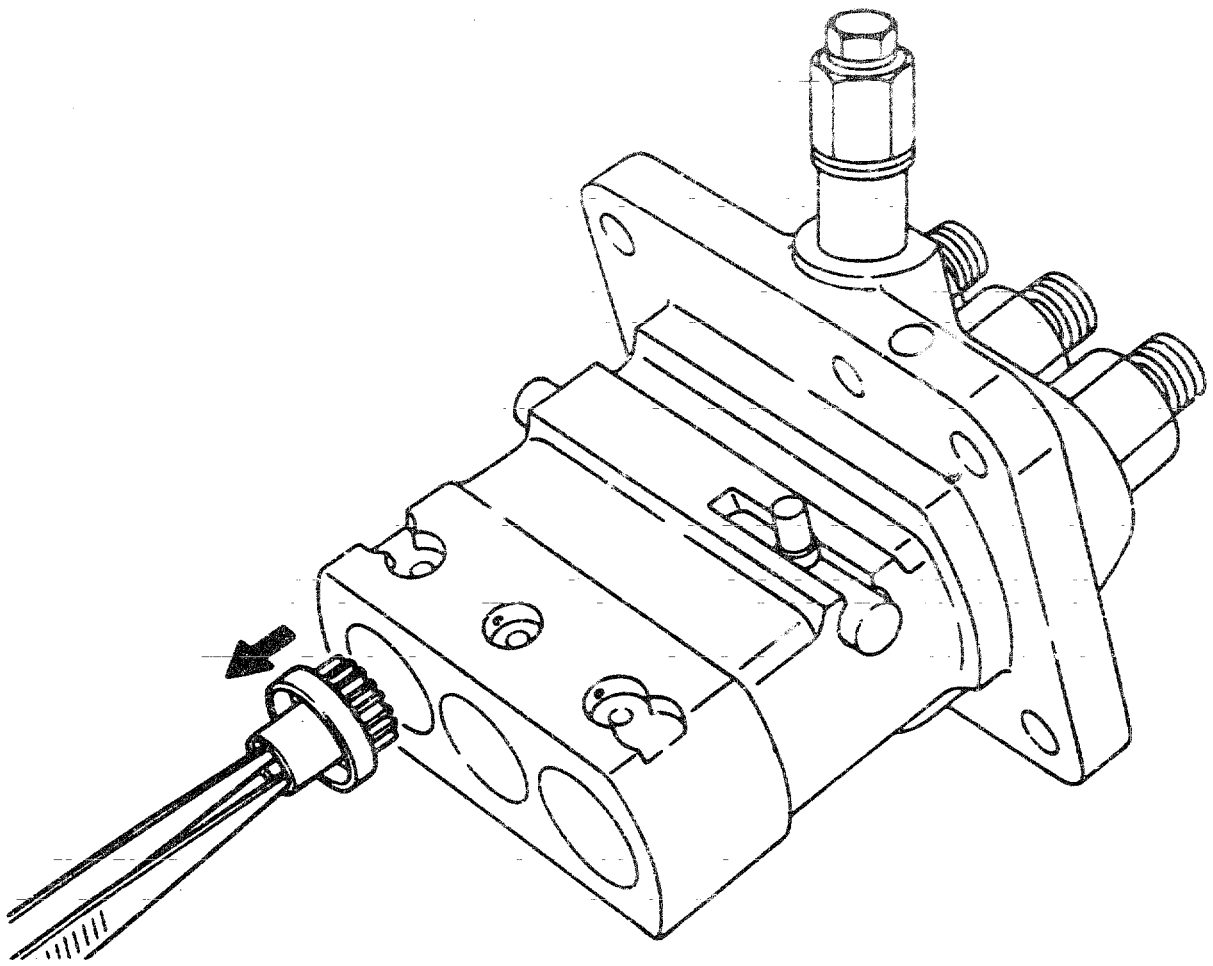


Fig. 24 Removing control sleeve and spring seat

5. Remove the control sleeve (77) and spring seat (51) from the plunger barrel (5).

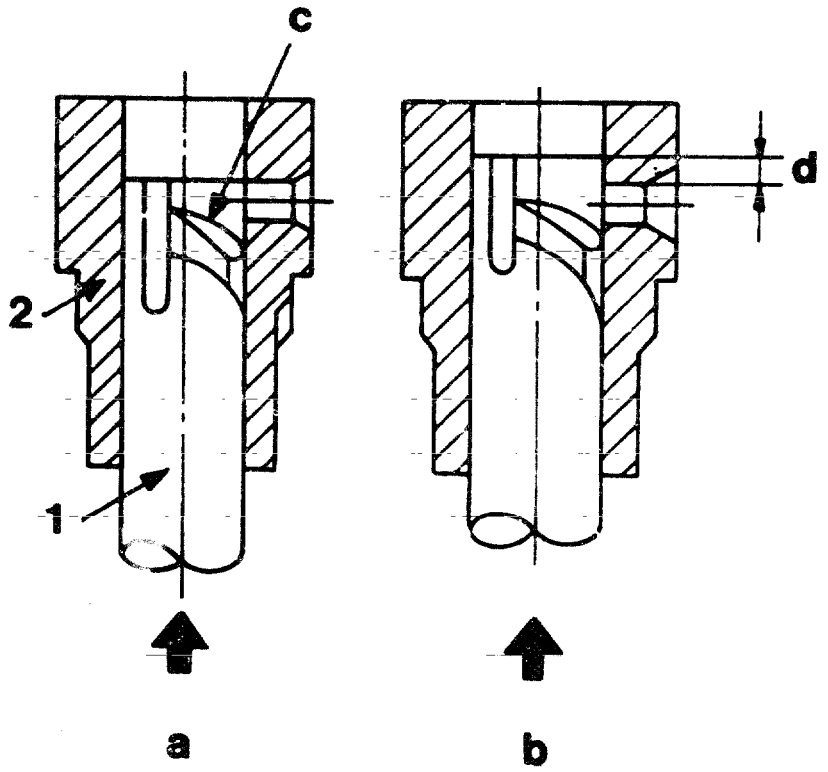


Fig. 9

1 = Plunger
2 = Plunger barrel

a = Delivery starts
b = Delivery ends
c = Helix
d = Effective stroke

If the plunger is rotated, the effective stroke shown in Fig. 9 is altered, and consequently fuel injection quantity is altered.

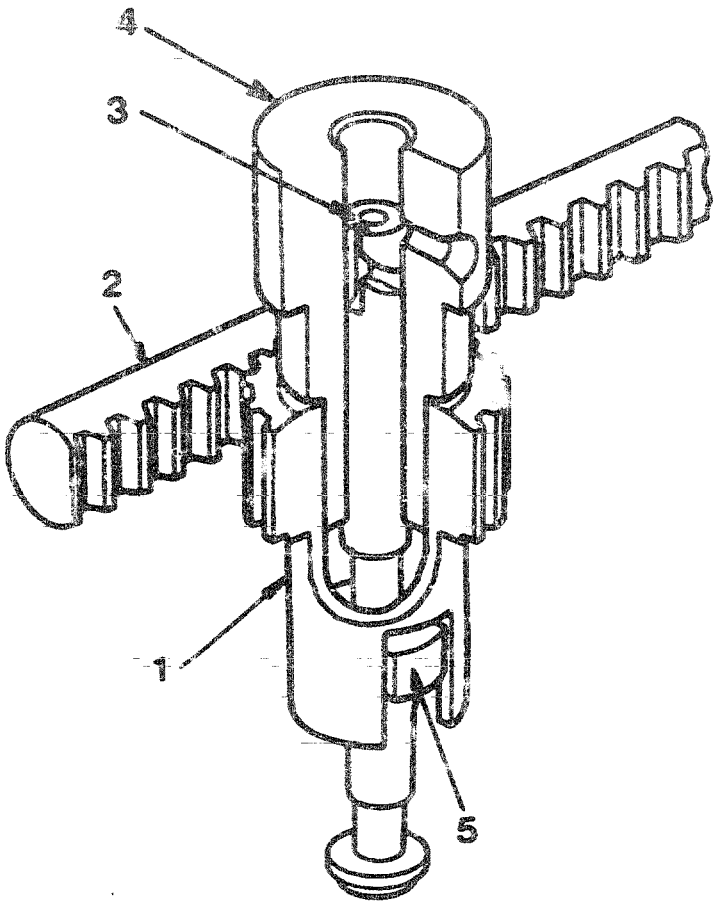


Fig. 10 PFR-KD pump Rotating mechanism

1 = Control sleeve
2 = Control rack
3 = Plunger
4 = Plunger barrel
5 = Flange

With the PFR-KD pump, the flange at the lower portion of the plunger is inserted into the groove of the control sleeve, and teeth on the control sleeve's upper portion are engaged with the teeth of the control rack. Accordingly, the plunger rotates when the control rack is moved and the injection quantity is therefore altered.

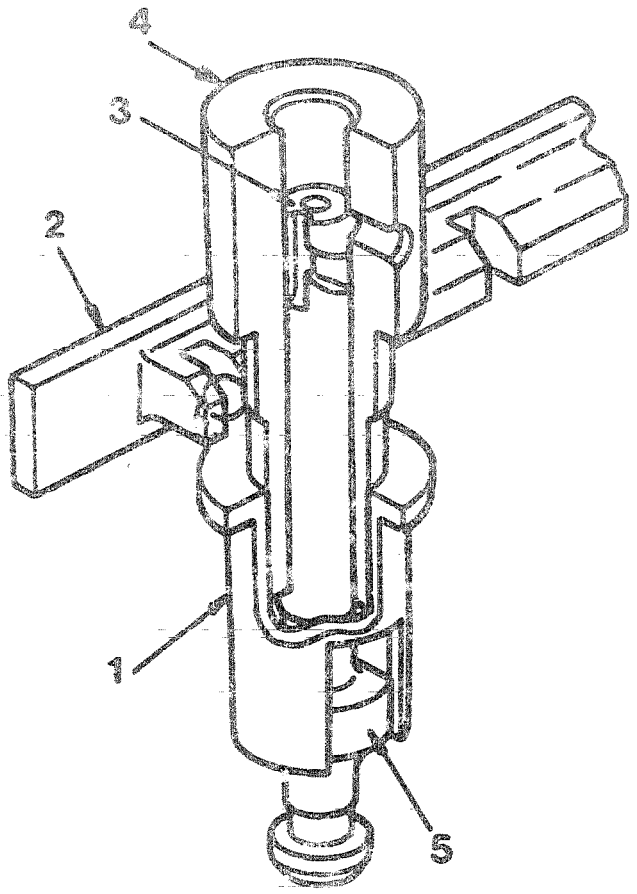


Fig. 11 PFR-MD pump Rotating mechanism

1 = Control sleeve
2 = Control rod
3 = Plunger
4 = Plunger barrel
5 = Flange

With the PFR-MD pump, the ball at the upper portion of the control sleeve is inserted into the control rod groove. Similarly, the plunger rotates and the injection quantity is altered when the control rod is moved. Movement is through the control rack (or rod), connected to the governer attached inside the timing gear case of the engine.

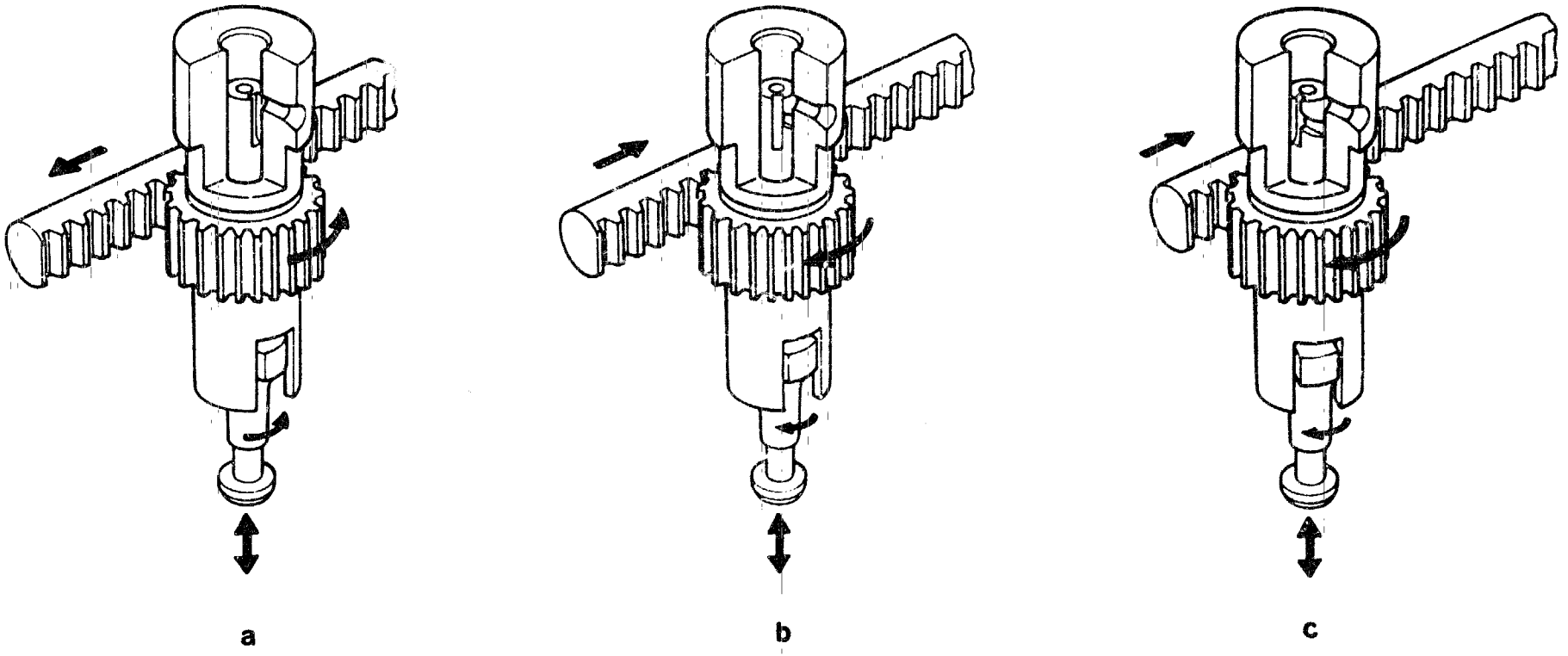


Figure 12

a = Non delivery

b = Partial delivery

c = Maximum delivery

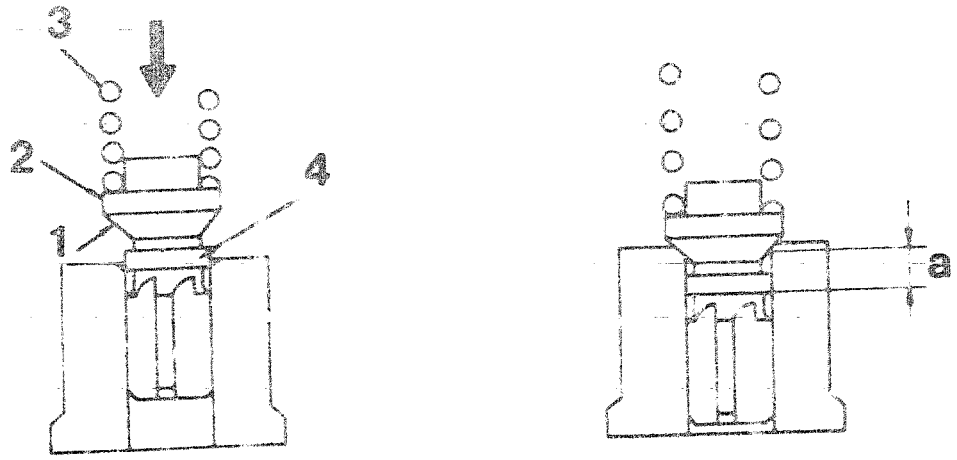


Fig. 13

1 = Seat portion
2 = Delivery valve
3 = Delivery valve spring
4 = Piston
a = Retraction stroke

The delivery valve delivers high pressure fuel oil to the nozzle through the injection pipe. After the plunger finishes delivery of fuel oil, the delivery valve prevents reverse flow of the fuel oil from the injection pipe to the plunger barrel. When the delivery valve descends, fuel oil pressure inside the injection pipe is reduced by the absorbing action of the piston, in order to prevent any leakage of fuel oil after the nozzle is closed.

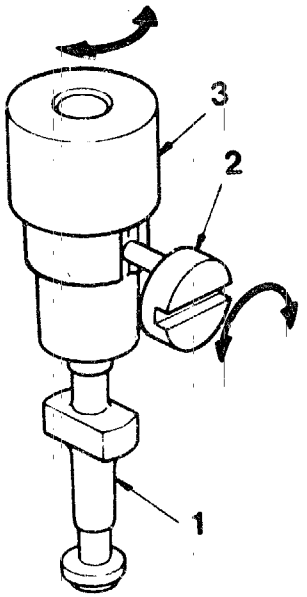


Fig. 14 PFR-KD pump

1 = Plunger
2 = Eccentric pin
3 = Plunger barrel

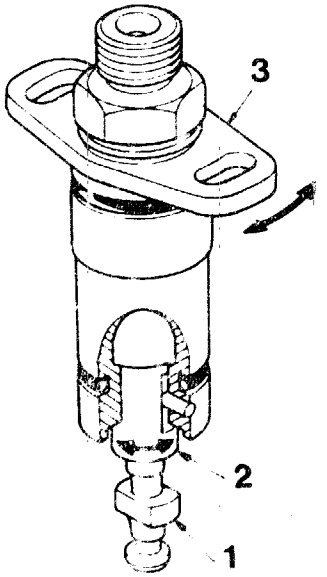


Fig. 15 PFR-MD pump

1 = Plunger
2 = Plunger barrel
3 = Sleeve flange

In both the PFR-KD and PFR-MD pumps, fuel injection quantity can be adjusted. The mechanisms are shown in Figs. 14 and 15. By turning the eccentric pin, for the PFR-KD pump, and the sleeve flange, for the PFR-MD pump, the plunger barrel is rotated and fuel injection quantity is therefore altered.

The plate incorporated between the plunger and tappet is used for adjusting the plunger pre-stroke. (Figs. 5 and 6)

SPECIAL TOOLS

Tools for disassembly and reassembly

The following special tools (in addition to regular tools) are required for disassembly and reassembly of the PFR-KD and PFR-MD fuel injection pumps:

No.	Part number	Tool name	Application
1	Commercially available	Wrench	Attaching and detaching the delivery valve holder of the PFR-KD pump (width across flats: 19 mm, total length: 55 mm).
2	Commercially available	Wrench	Attaching and detaching the delivery valve holder of the PFR-MD pump (width across flats: 17 mm, outside diameter: 22 mm).
3	Commercially available	Wrench	Attaching and detaching the sleeve flange fixing bolt of the PFR-MD pump (star shaped).
4	Commercially available	Wrench	Attaching and detaching the sleeve flange fixing bolt of the PFR-MD pump (width across flats: 5 mm).
5	Commercially available	Pincette	Attaching and detaching the control sleeve, plunger, etc.

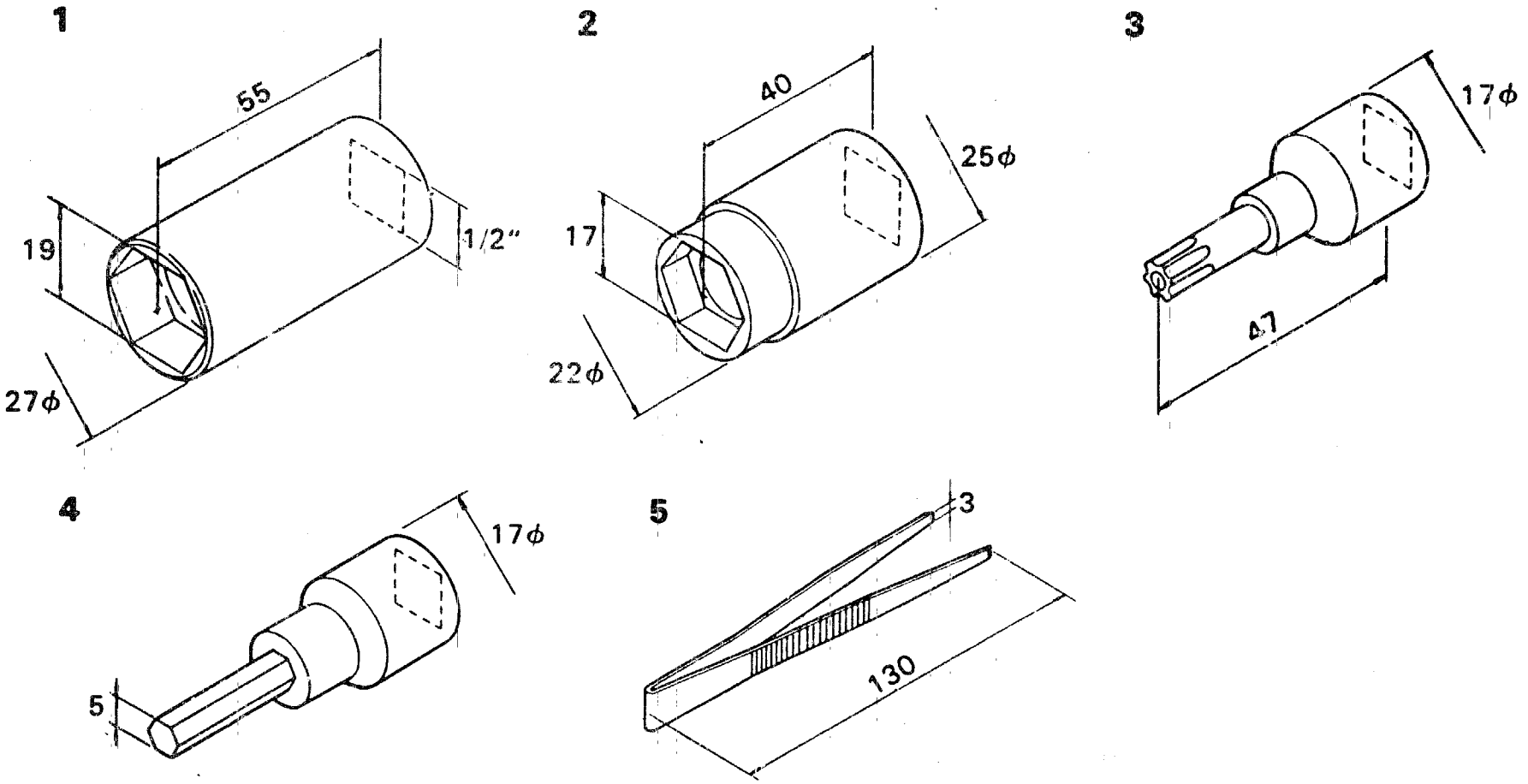


Figure 16

Tools for disassembly and reassembly

1 = Wrench

2 = Wrench

3 = Wrench

4 = Wrench

5 = Pincette

Adjustment Tools

In addition to the pump test stand, the following special tools are required for adjustment of the PFR-KD and PFR-MD pumps:

No.	Part number	Tool name	Application
1	KDDC 0001	Driving stand	Mounting bracket for PFR 1-KD pump
1	KDDC 0002	Driving stand	Mounting bracket for PFR 2-KD pump
1	KDDC 0003	Driving stand	Mounting bracket for PFR 3-KD pump
1	KDDC 0004	Driving stand	Mounting bracket for PFR 4-KD pump
2	KDDC 0005	Driving stand	Mounting bracket for PFR 1-MD pump
2	KDDC 0006	Driving stand	Mounting bracket for PFR 2-MD pump
2	KDDC 0007	Driving stand	Mounting bracket for PFR 3-MD pump
2	KDDC 0008	Driving stand	Mounting bracket for PFR 4-MD pump
3	KDDC 0009	Calibrating-nozzle assemb.	For adjusting PFR-KD, MD pumps
4	1 680 750 014	Test-pressure line	For adjusting PFR-KD, MD pumps (2 mm x 6 mm - 600 mm M 14x1.5 - M 12x1.5)
5	Commercial. available	Wrench	For discharging air from test nozzle holder
6	KDDC 0010	Measuring device	For measuring plunger pre-stroke of PFR-KD pump
7	KDDC 0011	Measuring device	For measuring plunger pre-stroke of PFR-MD pump
8	KDDC 0012	Measuring device	For measuring control rack travel of PFR-KD, MD pumps
9	Commercial. available	Eye	For connecting piping to test oil supply port (PFR-MD pump)
10	Commercial. available	Eye	For connecting piping to test oil supply port (PFR-KD pump)
11	Commercial. available	Gasket	As above
12	Commercial. available	Eye bolt	As above
13	Commercial. available	Bolt	For pump test stand model 7 NP and 15 NP (used together with adapter, 50 mm long)
14	Commercial. available	Adapter	For pump test stand model 7 NP and 15 NP (inserted between the driving stand and the bed of the test stand, t = 15 mm)

Note:

As described below, the driving stand consists of the pump stand, cam box and cam box stand. By selecting the appropriate stand, 1 to 4 cylinder pumps can be adjusted using a minimum number of tools. For example, using a driving stand for the PFR 1 MD pump (105781-4180) and three pump stands (157814-8820, 157814-8920 and 157814-9020), the PFR 1 MD through 4 MD pumps can be adjusted.

Injection pump	Driving stand
PFR 1 MD	KDDC 0005
PFR 2 MD	KDDC 0006
PFR 3 MD	KDDC 0007
PFR 4 MD	KDDC 0008
PFR 1 KD	KDDC 0001
PFR 2 KD	KDDC 0002
PFR 3 KD	KDDC 0003
PFR 4 KD	KDDC 0004

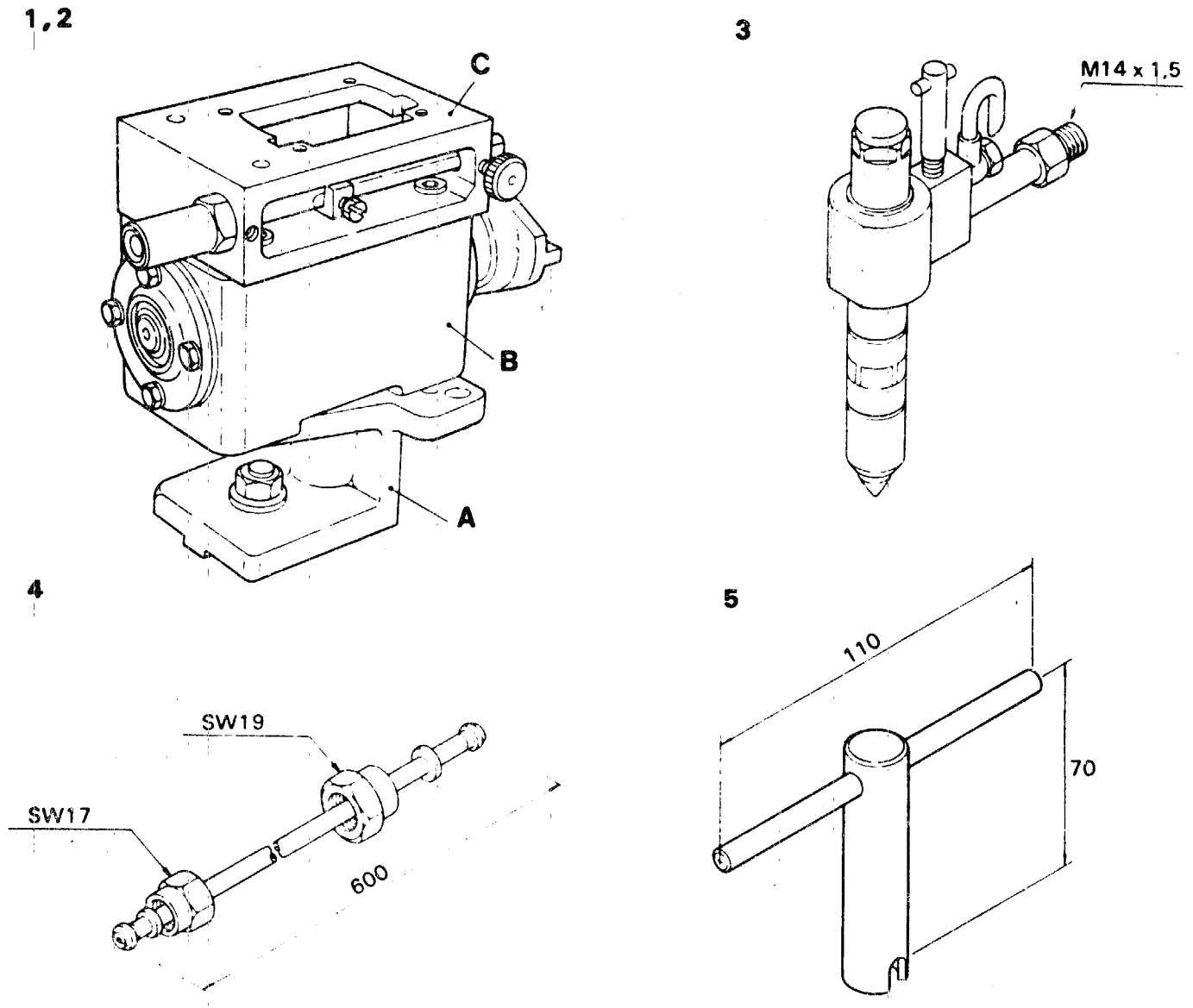
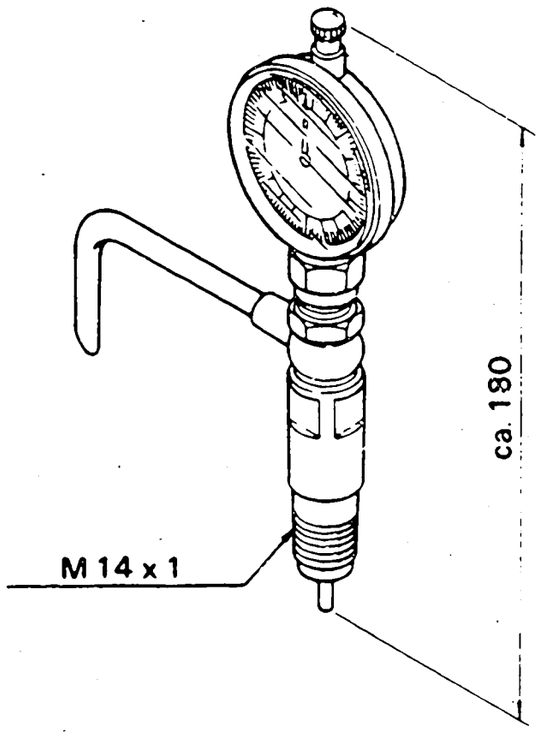


Figure 17 Adjustment tools

1,2 = Driving stand
3 = Calibrating-nozzle assembly
4 = Test-pressure line
5 = Wrench

A = Cam box stand
B = Cam box
C = Pump stand

6, 7



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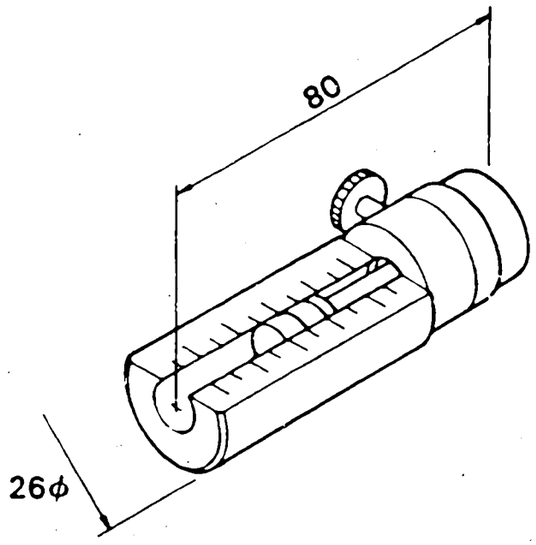

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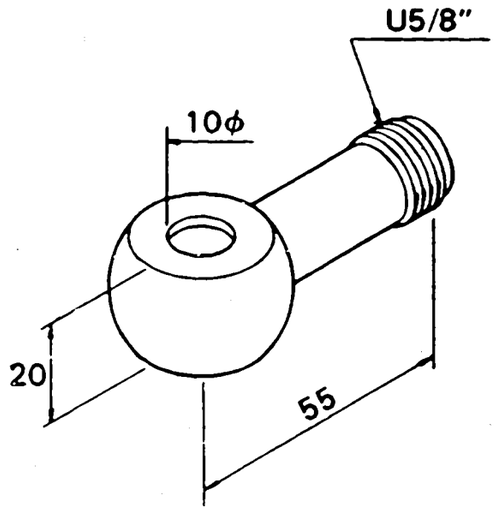

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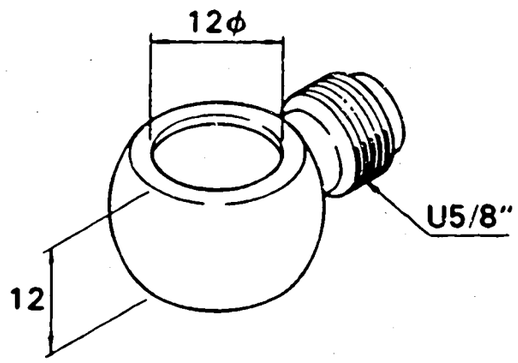

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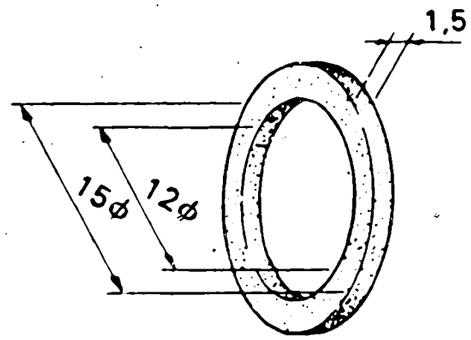

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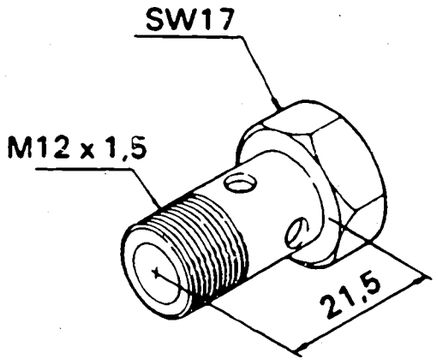

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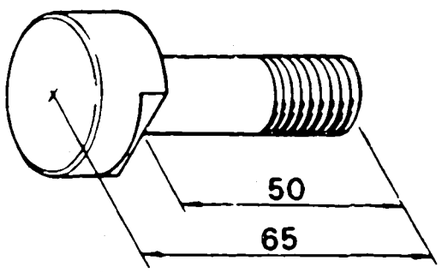

Bild 18 Einstellwerkzeuge

6, 7 = Meßvorrichtung
8 = Meßvorrichtung
9 = Ringstück
10 = Ringstück
11 = Dichtung
12 = Hohlschraube
13 = Schraube

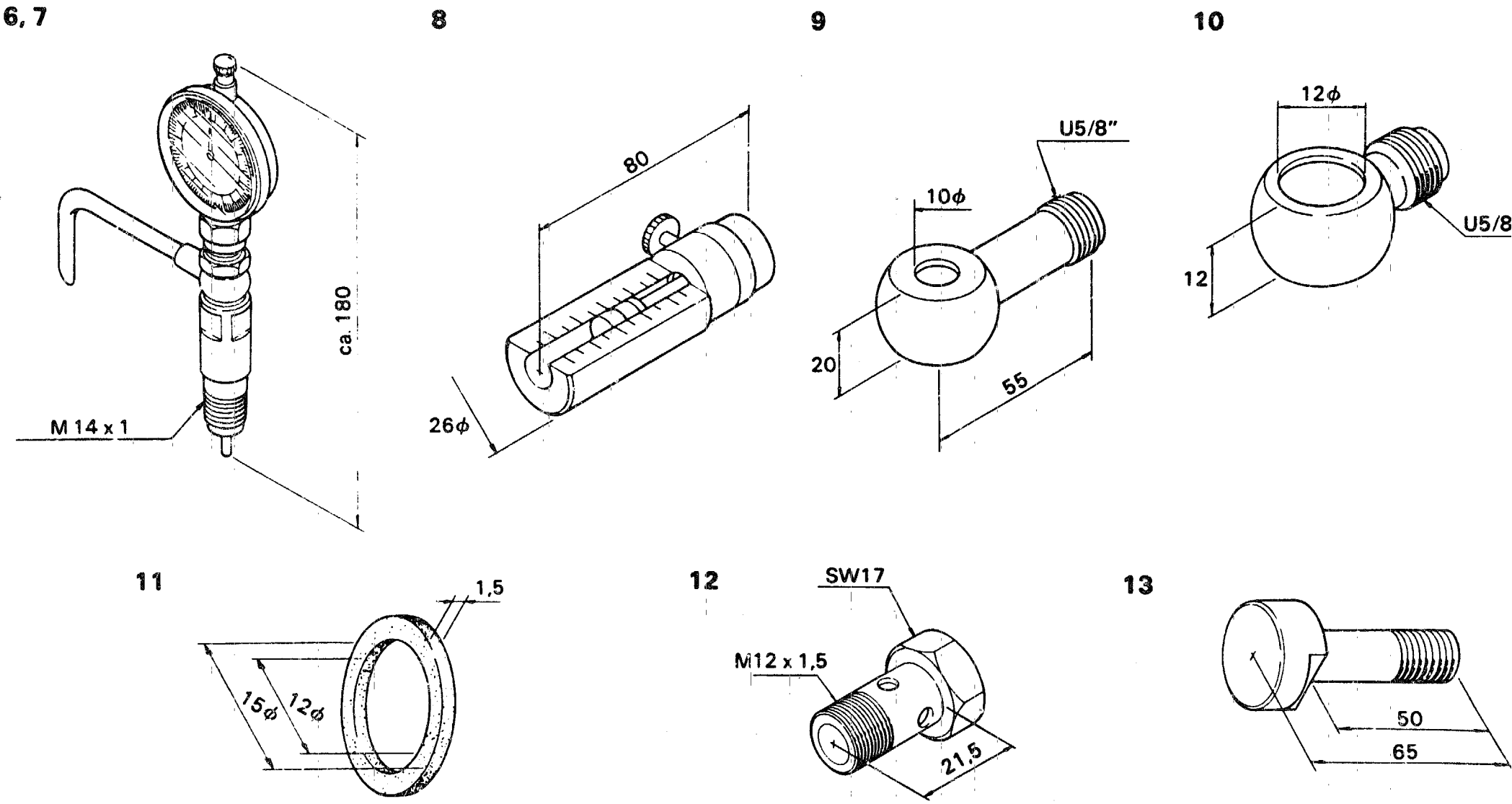

Figure 18 Adjustment tools

6, 7 = Measuring device
8 = Measuring device
9 = Eye
10 = Eye
11 = Gasket
12 = Eye bolt
13 = Bolt

14

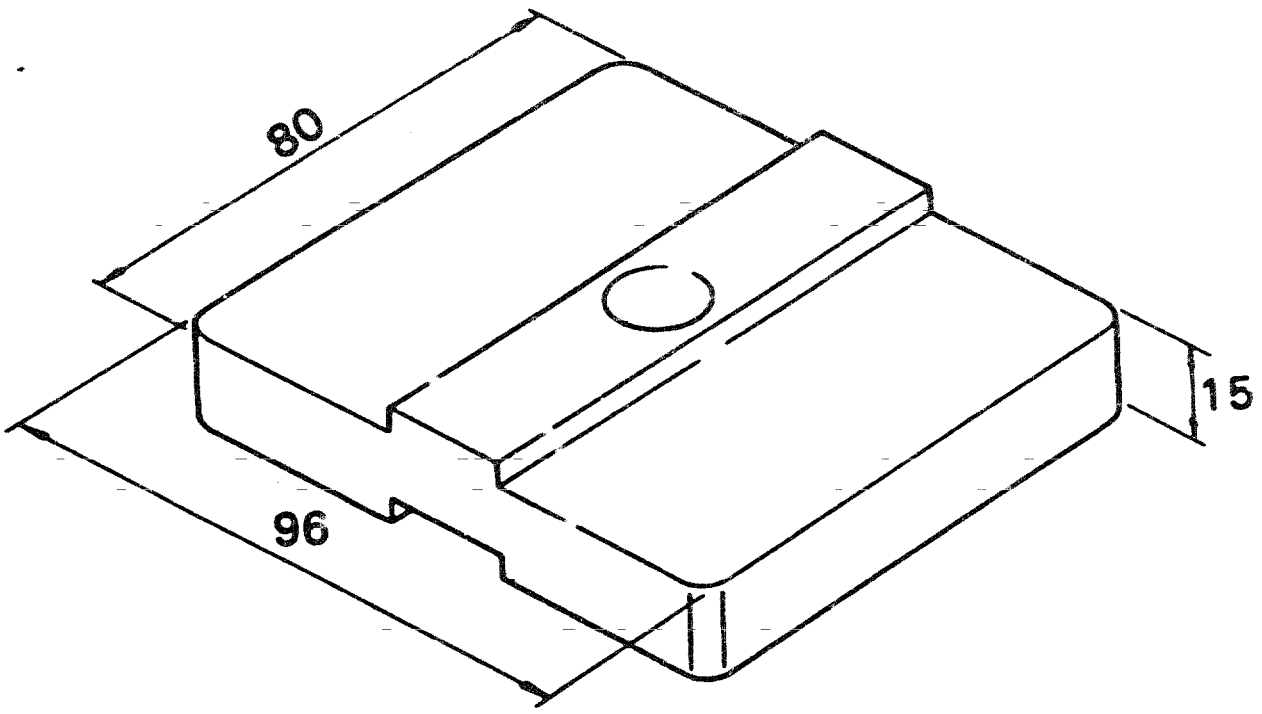

Fig. 18-1 Adjustment tool

14 = Adapter

14

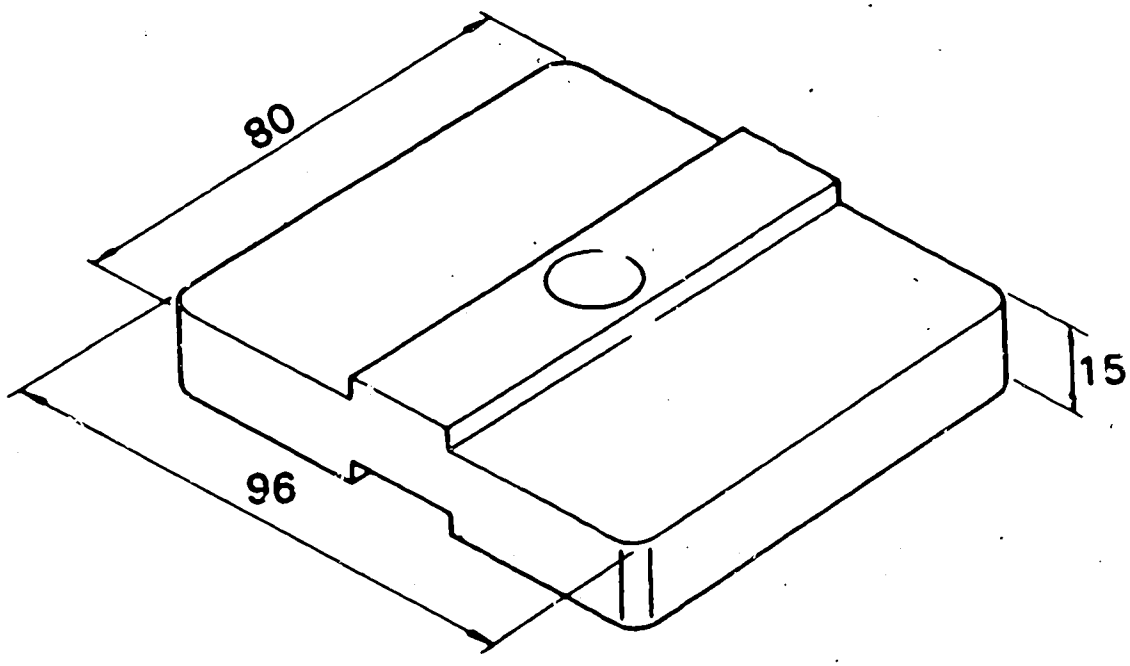

Bild 18-1 Einstellwerkzeug

14 = Adapter

1. Since the injection pump consists of precision parts, special care must be taken when handling.

2. After disassembly, parts must be reattached to the appropriate cylinder. (Never change the plunger/plunger barrel or the delivery valve/ delivery valve seat combinations.)

3. The disassembled parts should be placed neatly on the workbench, to ensure that operations proceed correctly.

4. Before disassembly, clean any engine oil or foreign matter from the external surface of the injection pump.

PFR-KD Type Injection Pump

The PFR 3-KD type pump disassembly is explained following. The numbers in parenthesis following the part name indicate the key numbers given in Fig. 19 and tools part numbers.

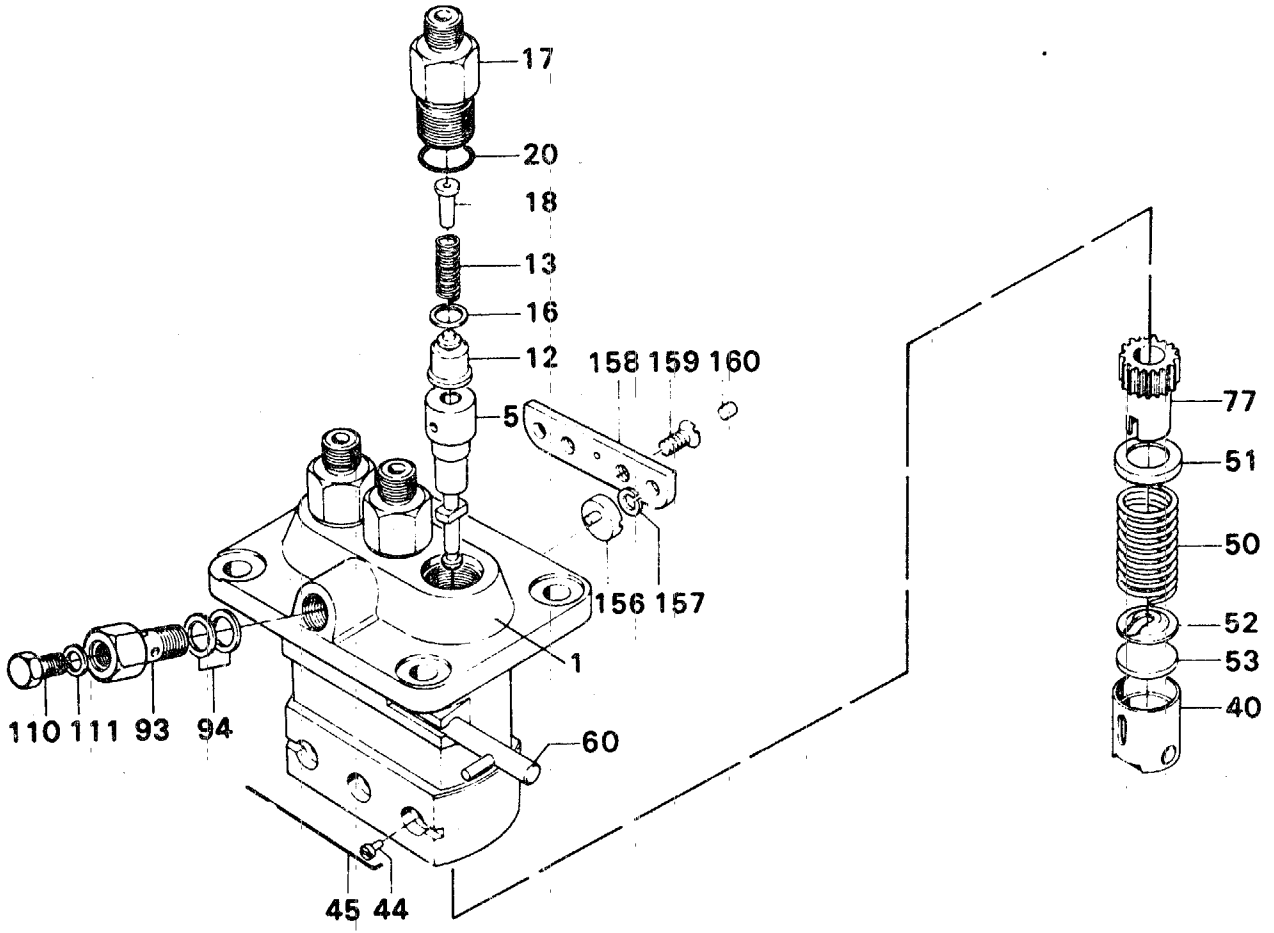

Fig. 19 Exploded view of PFR 3-KD pump

1 = Pump housing
5 = Plunger assembly
12 = Delivery valve assembly
13 = Delivery valve spring
16 = Gasket
17 = Delivery valve holder
18 = Delivery valve stopper
20 = O-ring
40 = Tappet assembly
44 = Pin
45 = Wire
50 = Plunger spring
51 = Spring seat
52 = Spring seat
53 = Plate
60 = Control rack
77 = Control sleeve
93 = Eye bolt
94 = Gasket
110 = Bolt
111 = Gasket
156 = Eccentric pin
157 = Spring washer
158 = Cover
159 = Screw
160 = Plug

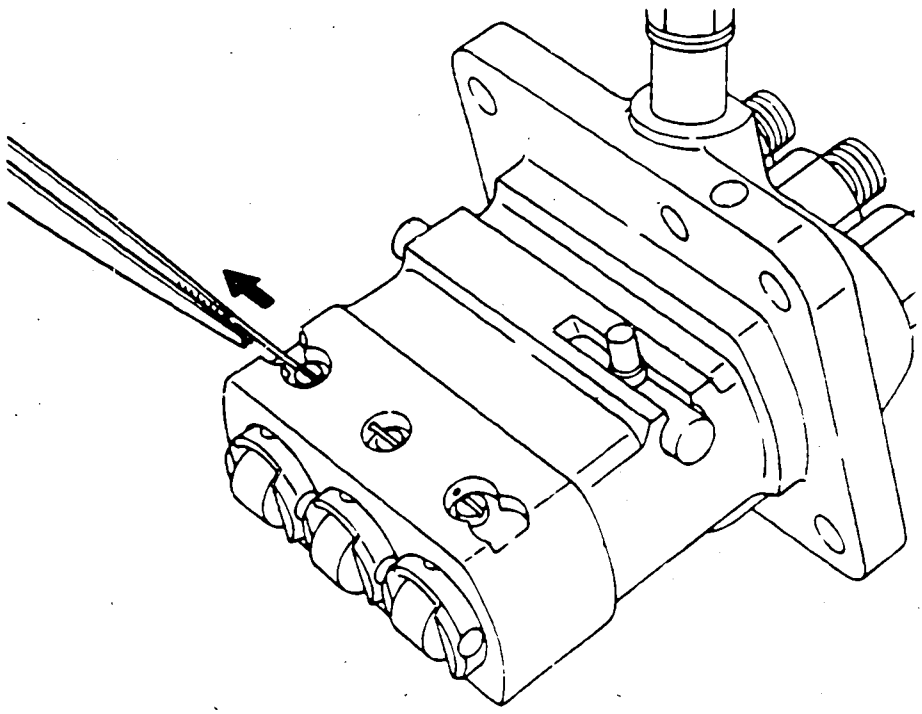

Bild 20 Draht herausziehen

1. Draht aus Pumpengehäuse herausziehen.

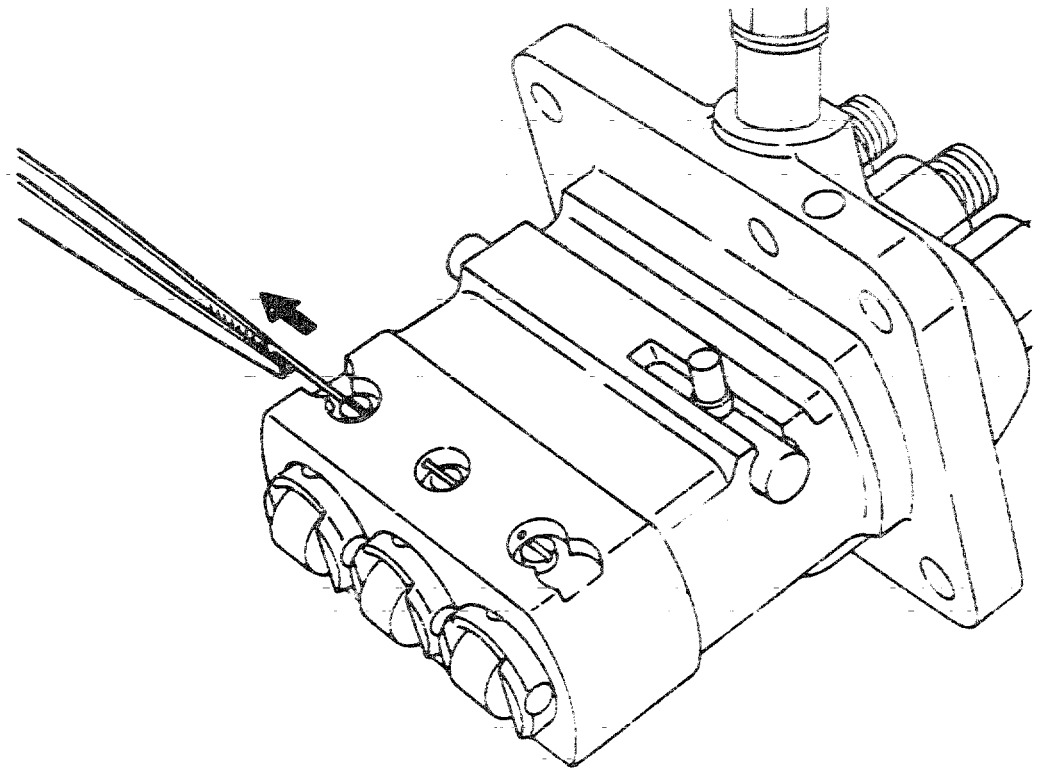

Fig. 20 Removing wire

1. Remove the wire from the pump housing.

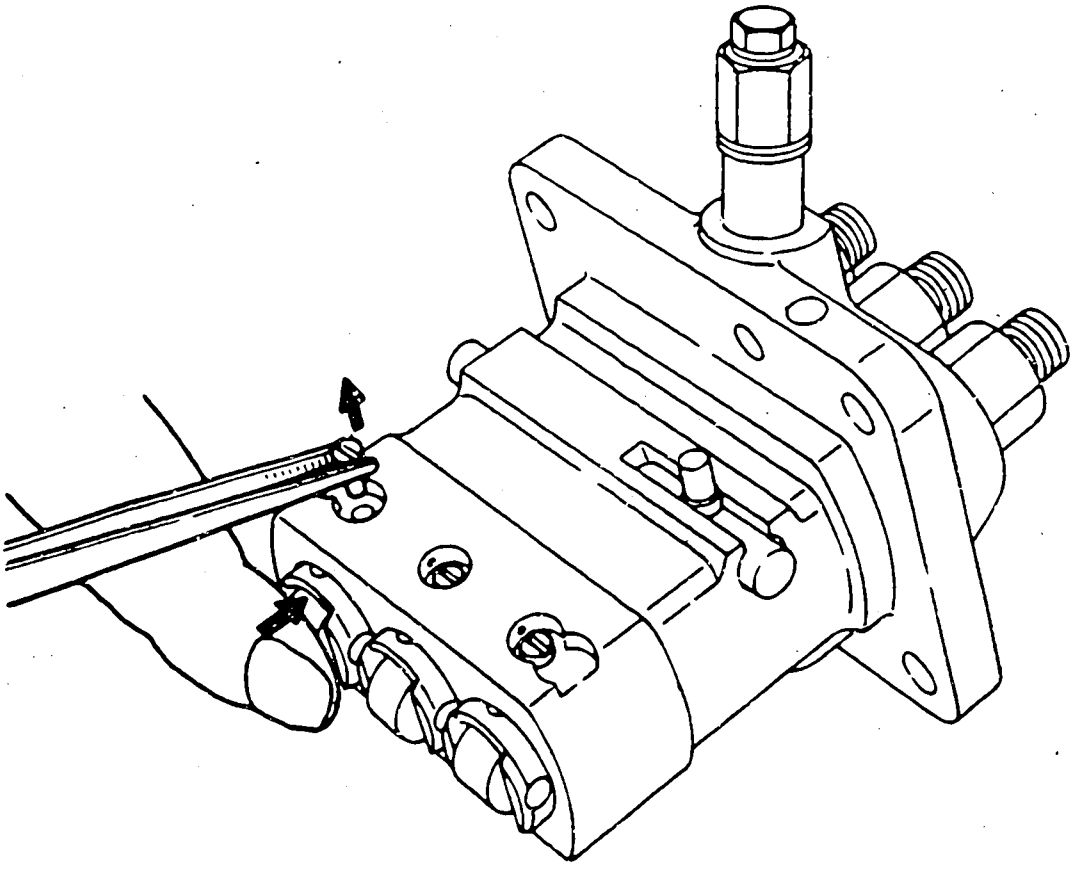

Bild 21 Bolzen herausziehen

2. Rollenstößel (40) niederdrücken und Bolzen (44) herausziehen.

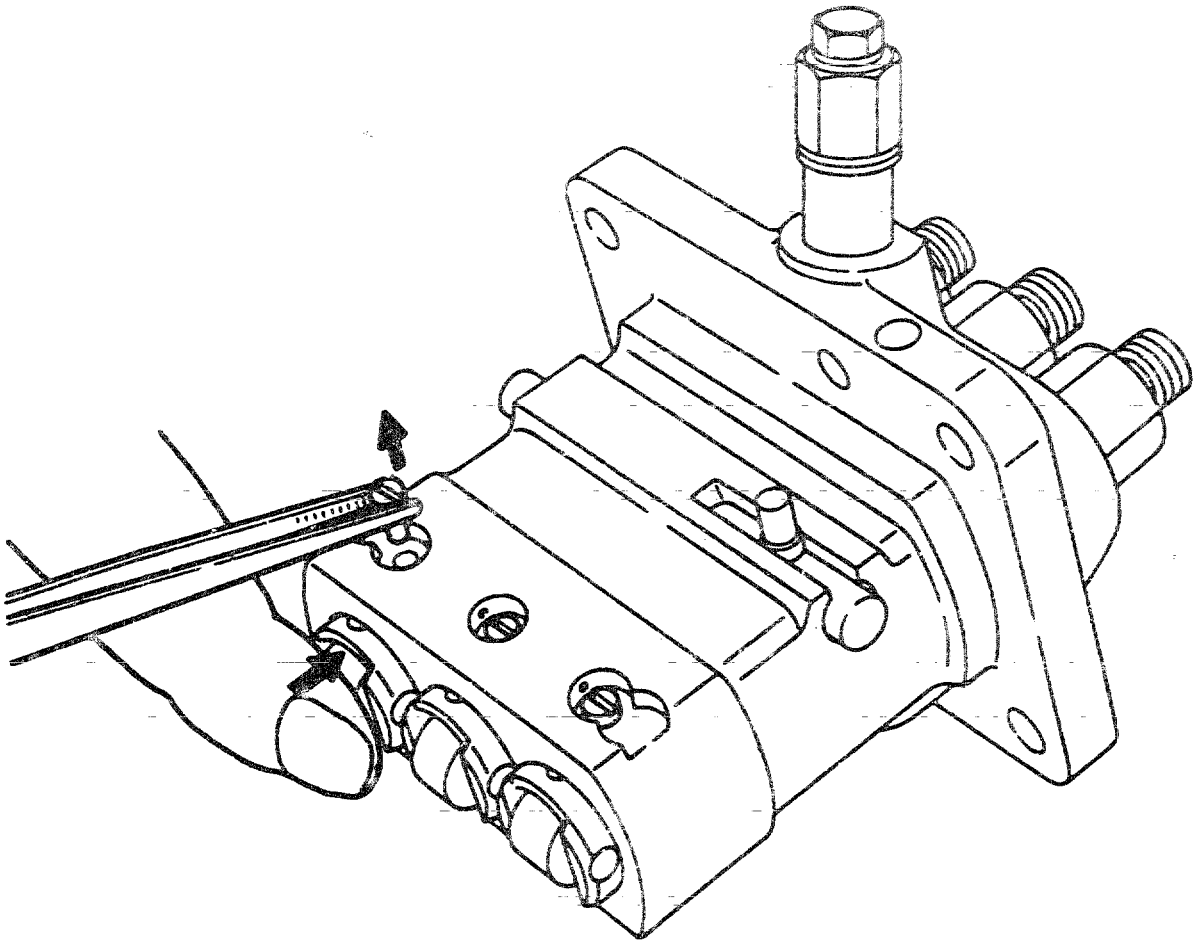

Fig. 21 Removing pin

2. Press the tappet (40) and remove the pin (44).

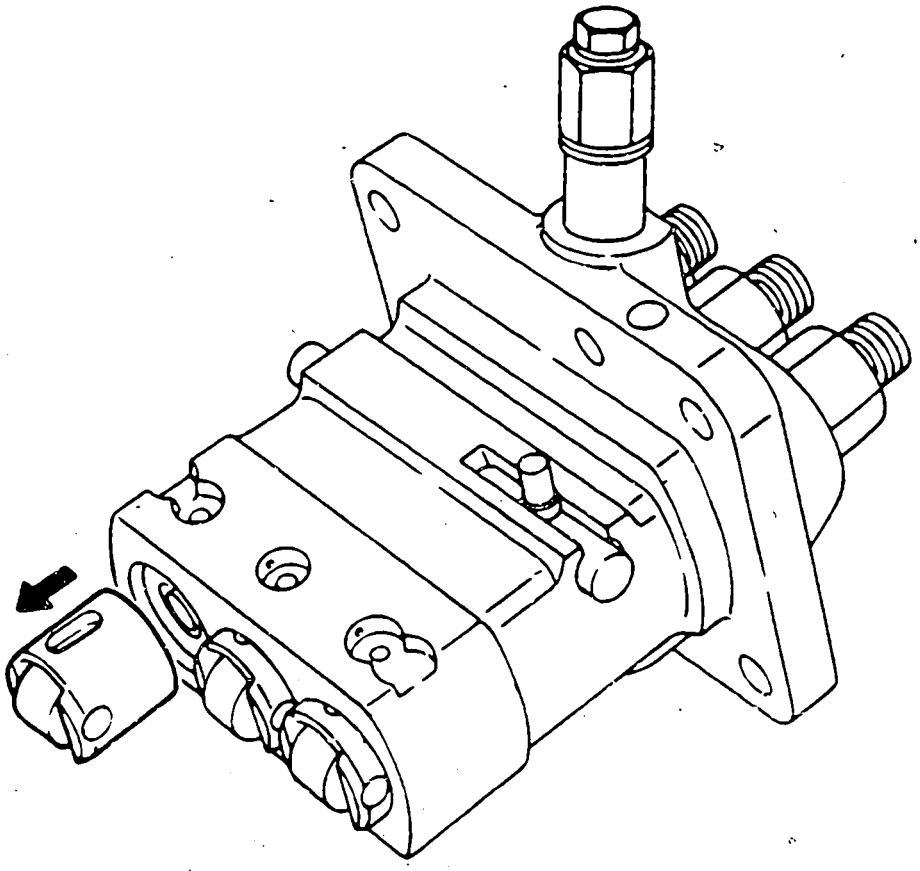

Bild 22 Rollenstößel und Scheibe herausnehmen

3. Rollenstößel und Scheibe (53) herausnehmen.

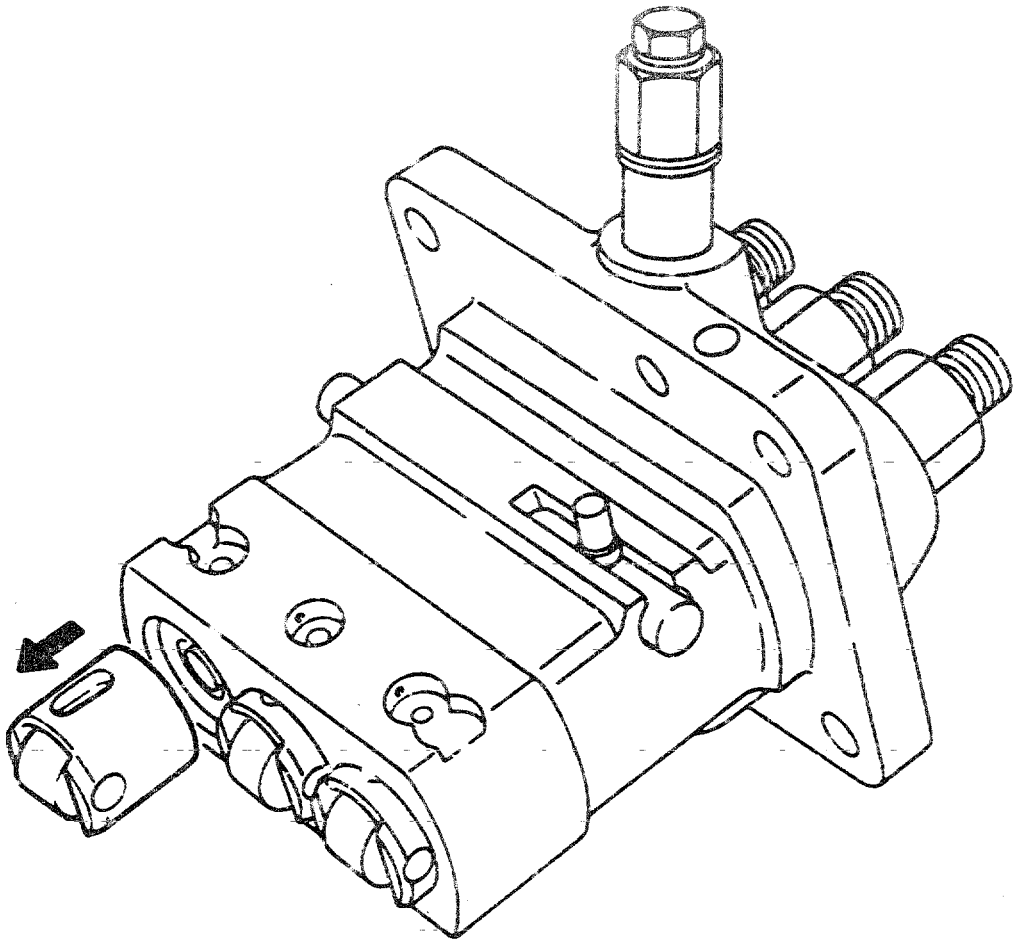

Fig. 22 Removing tappet and plate

3. Remove the tappet and plate (53).

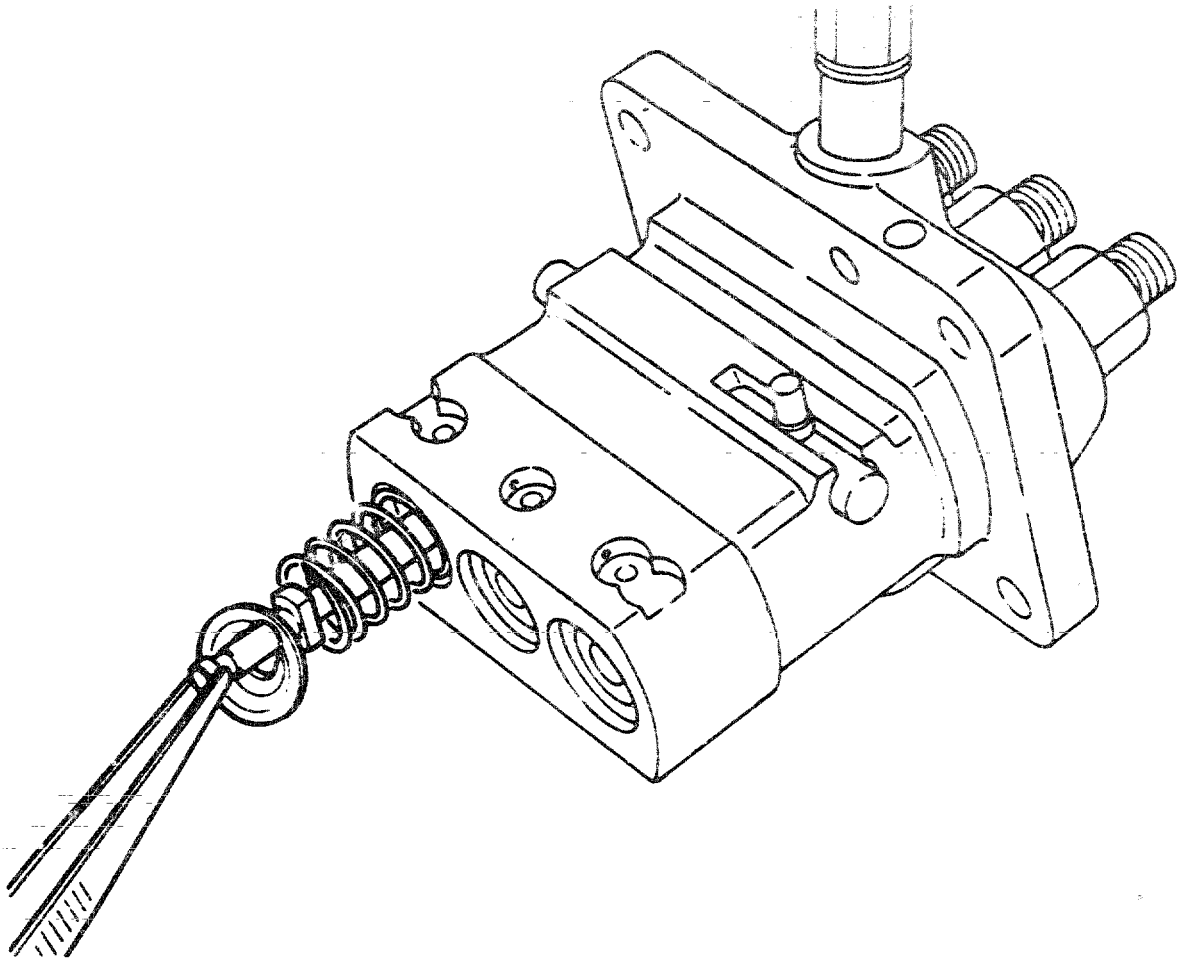

Fig. 23 Removing plunger, spring seat and plunger spring

4. Remove the plunger (5), spring seat (52) and plunger spring (50) together.

Note: Put plungers into clean fuel oil in the order of the cylinder numbers.

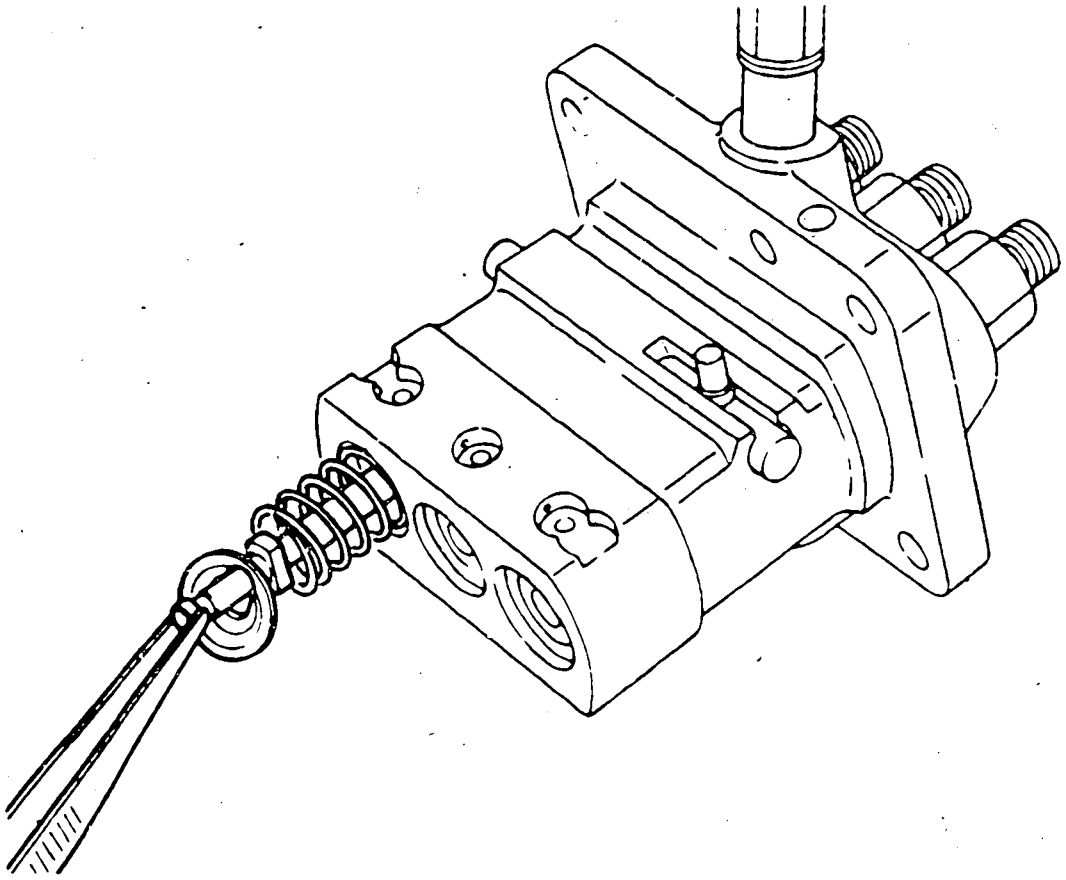

Bild 23 Pumpenkolben, Federteller und Kolbenfeder herausziehen

4. Pumpenkolben (5), Federteller (52) und Kolbenfeder (50) zusammen herausziehen.

Beachten:
Pumpenkolben in der Reihenfolge der Zylindernummern in sauberen Kraftstoff legen.

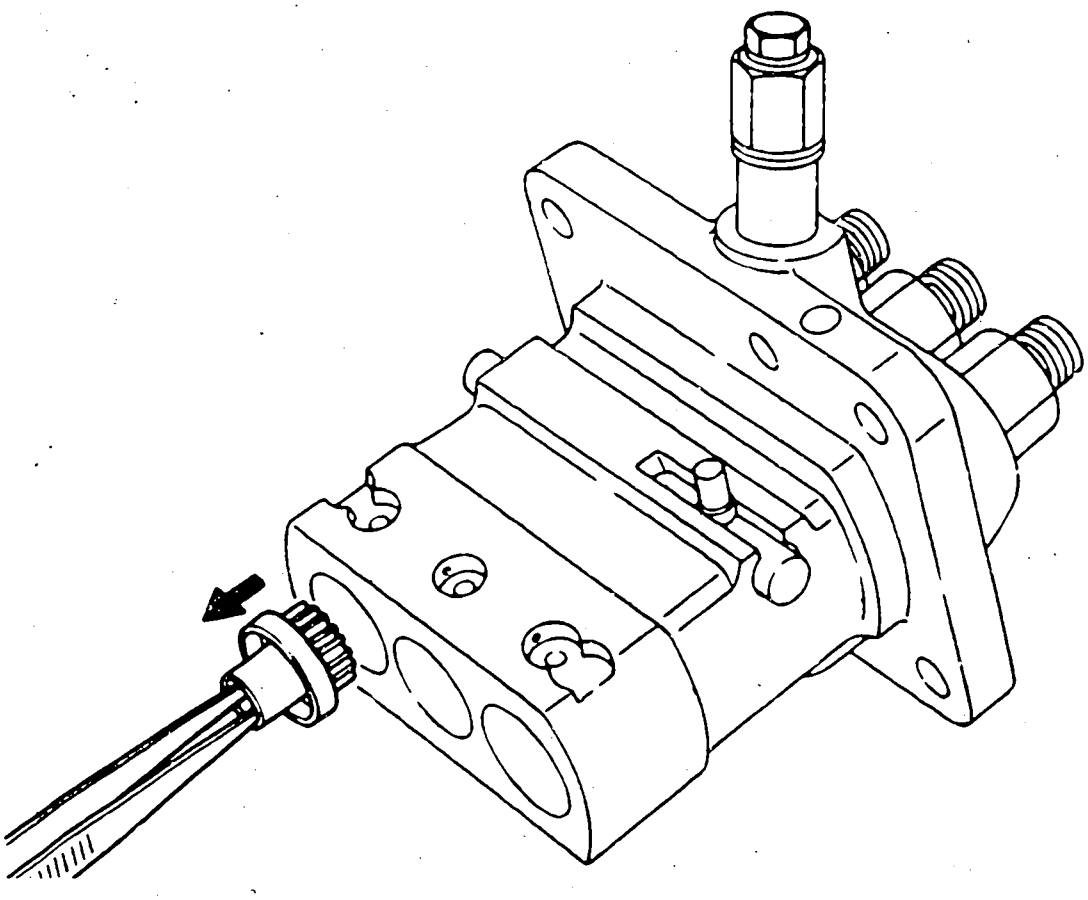

Bild 24 Regelhülse und Federteller herausnehmen

5. Regelhülse (77) und Federteller (51) aus Pumpenzylinder (5) herausnehmen.

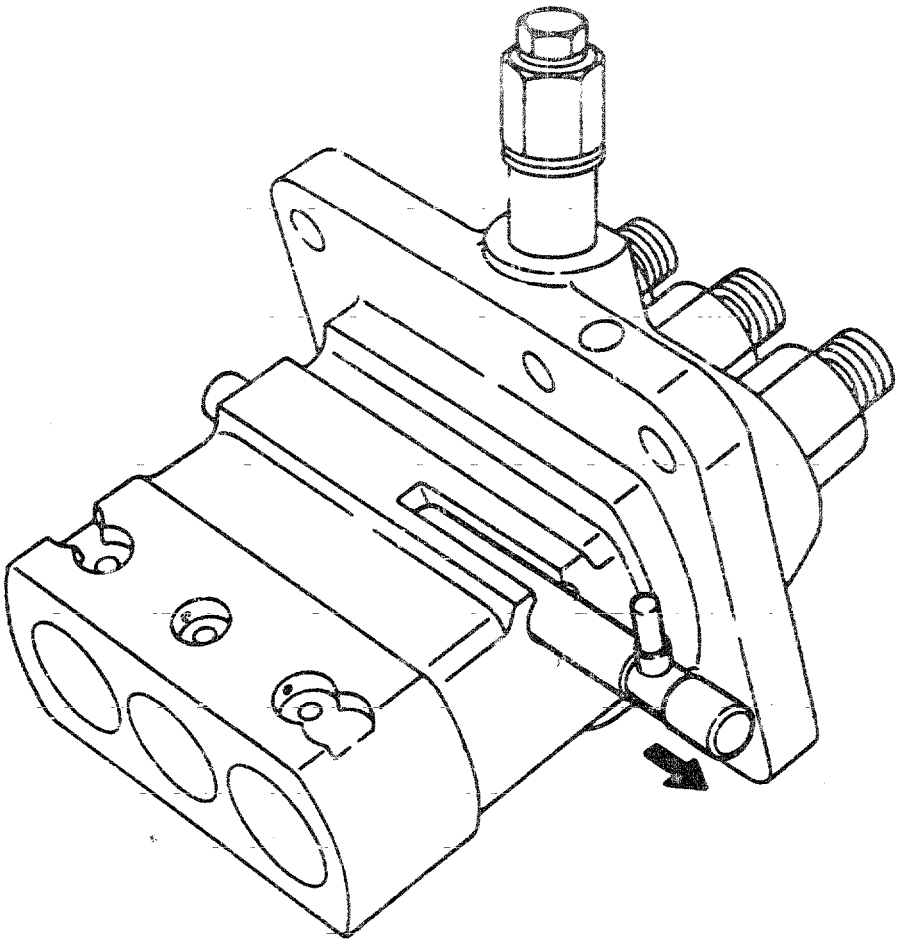

Fig. 25 Removing control rack

6. Remove the control rack (60) from the pump housing.

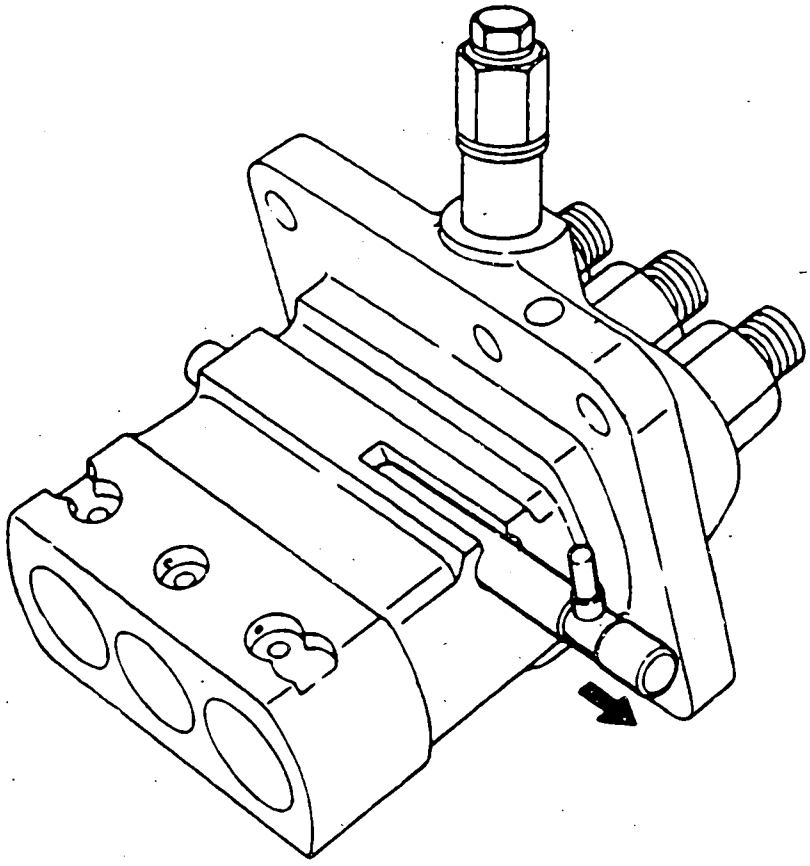

Bild 25 Regelstange herausziehen

6. Regelstange (60) aus Pumpengehäuse herausziehen.

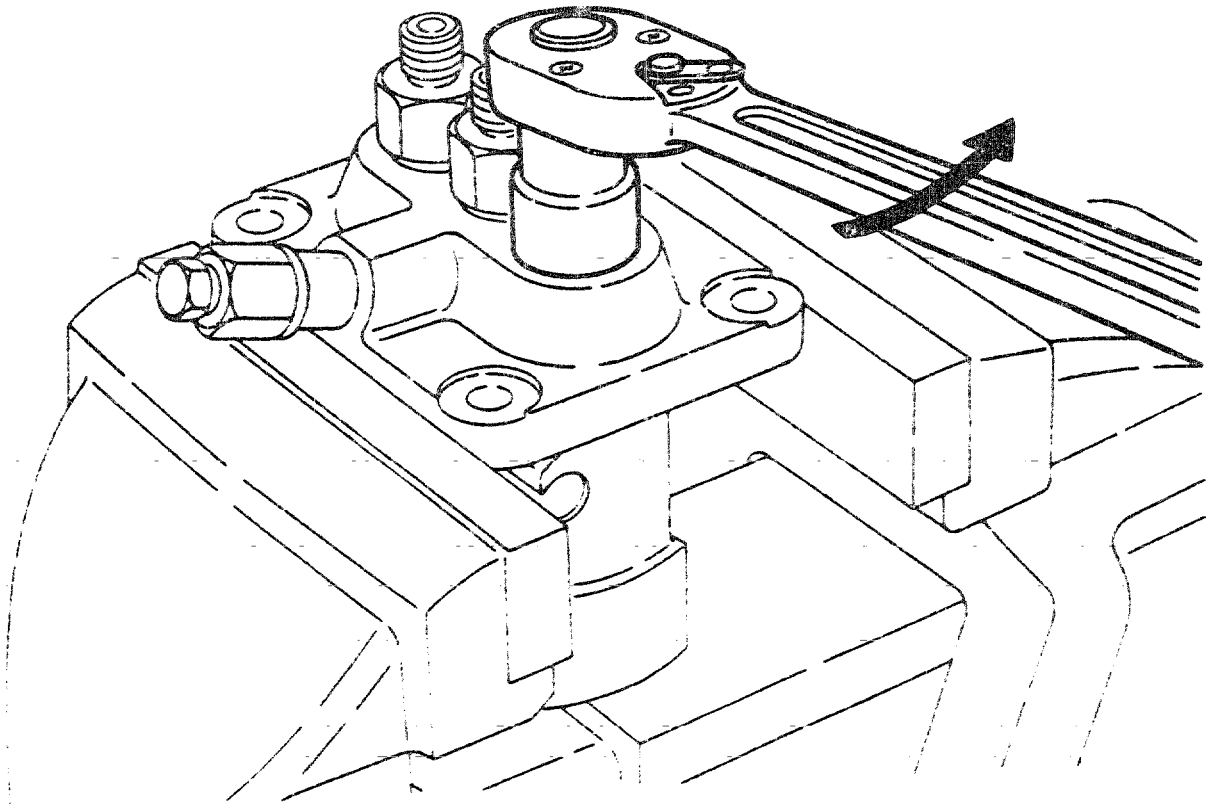

Fig. 26 Loosening delivery valve holder

7. Attach the pump housing to the vise and loosen the delivery valve holder (17) using a wrench.

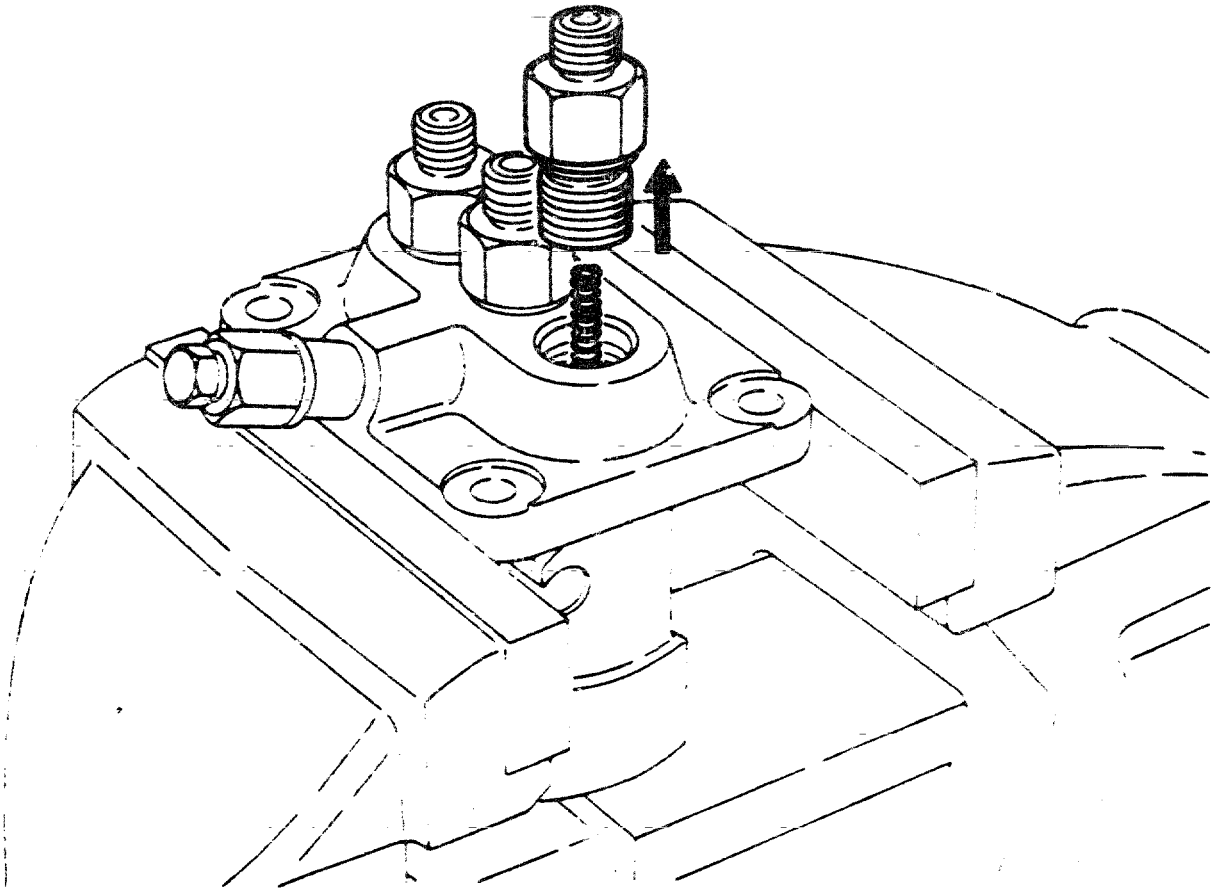

Fig. 27 Removing delivery valve holder

8. Remove the delivery valve holder. At this time, be careful not to drop or lose the delivery valve spring (13).

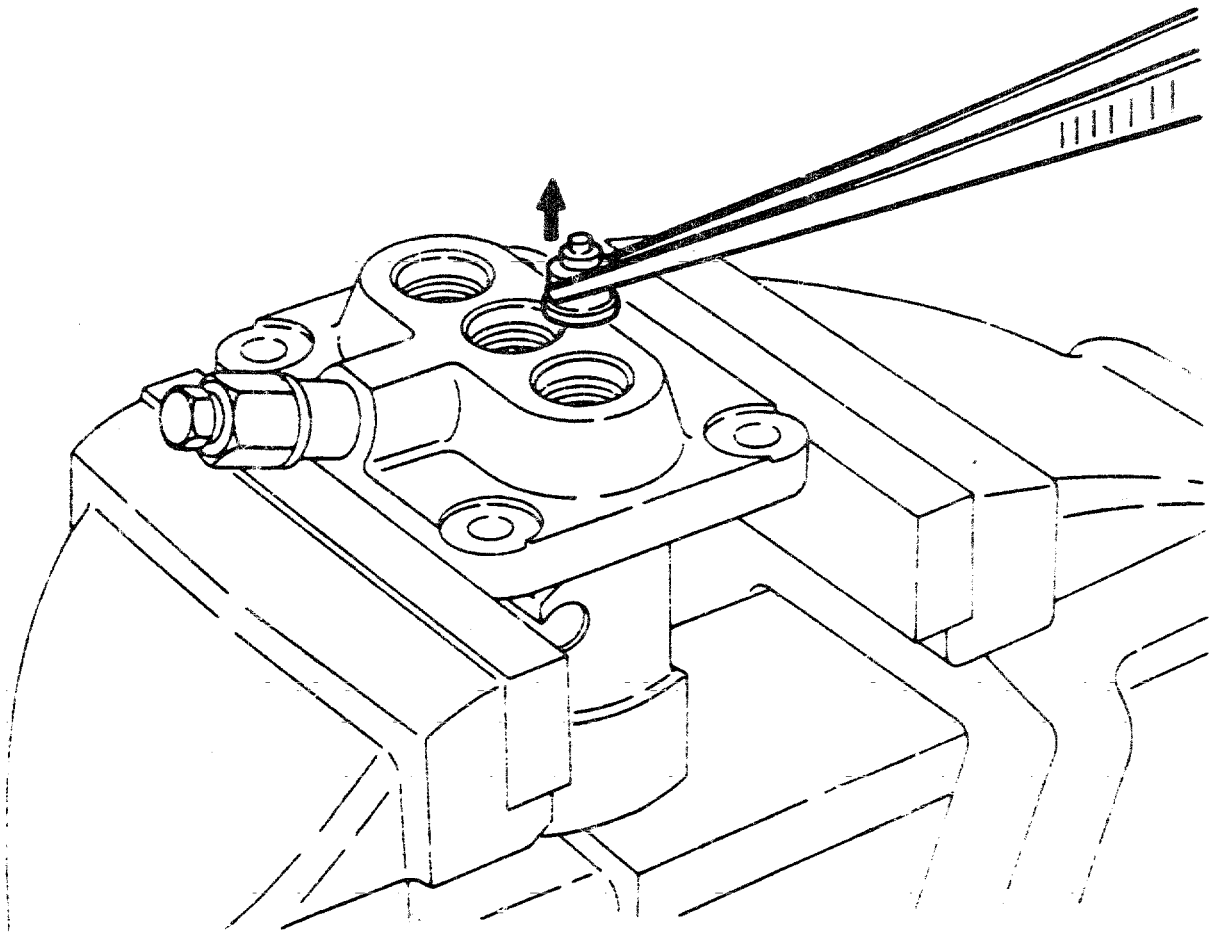

Fig. 28 Removing delivery valve assembly and gasket

9. Remove the delivery valve assembly (12) and gasket (16).

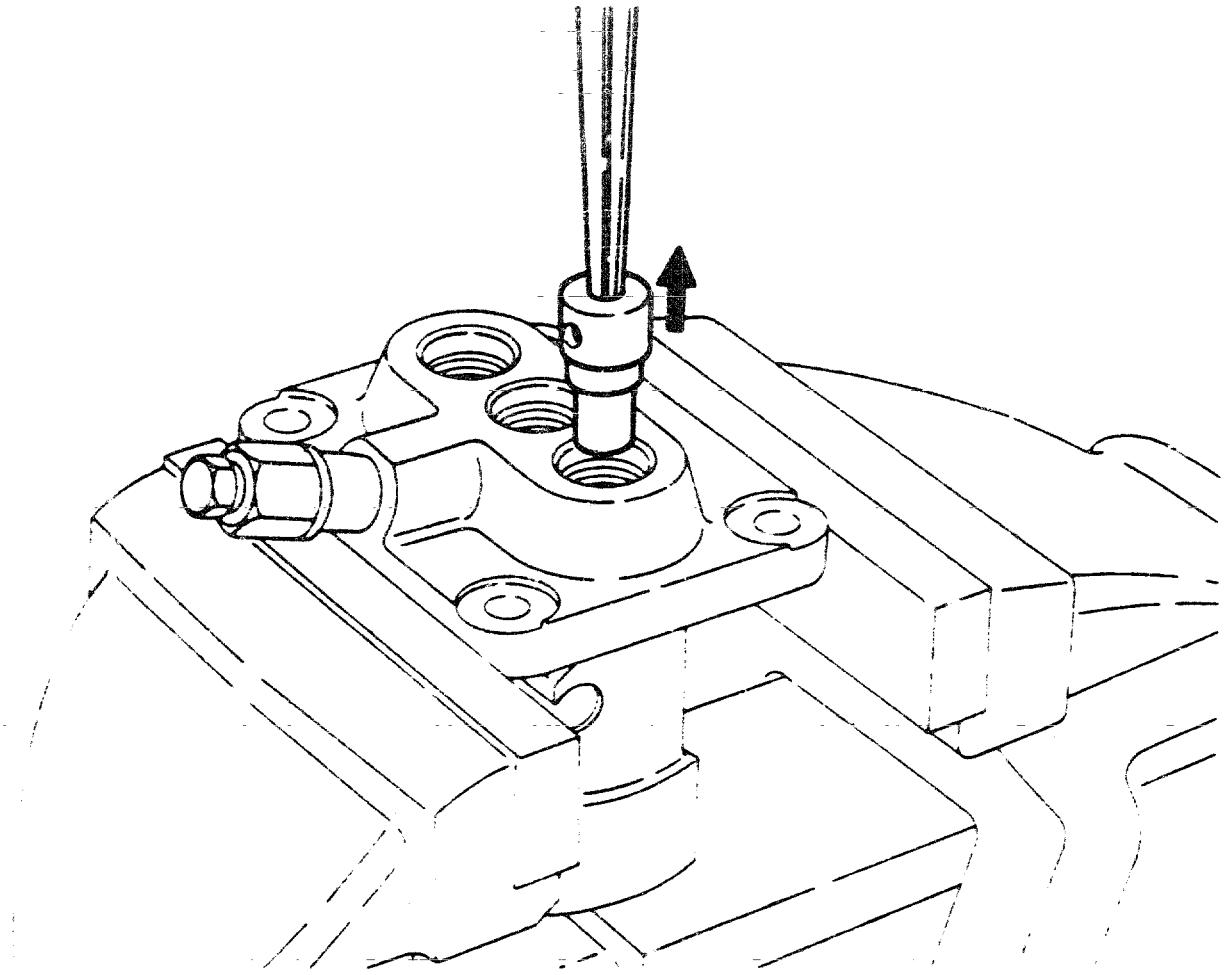

Fig. 29 Removing plunger barrel

10. Remove the plunger barrel. Attach it to the plunger previously removed, and put them in clean fuel oil.

Caution: Do not attach the plunger barrel to a different plunger.

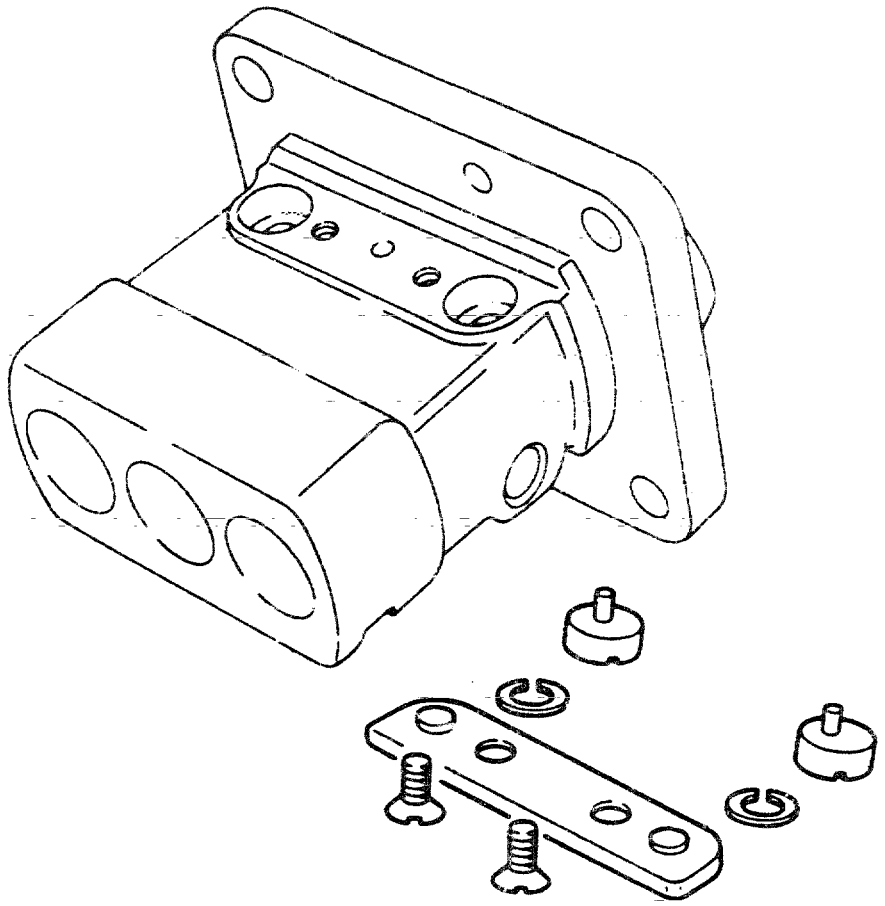

Fig. 30 Pins, cover, spring washers and screws

Disassembly of the PFR3KD pump is now complete.

Note: Do not remove the parts (157, 158 and 159) fixing the eccentric pin (156), except when adjusting fuel injection quantity.

Einspritzpumpe Typ PFR-MD

Nachstehend wird die Zerlegung der Einspritzpumpe Typ PFR 3 MD erläutert. Die in Klammern hinter der Teilbenennung angegebenen Zahlen sind die in Bild 31 aufgeführten Positionsnummern und die Werkzeug-Teilnummern.

The PFR 3-MD type pump disassembly is explained following. The numbers in parenthesis following the part name indicate the key numbers given in Fig. 31 and the tools part numbers.

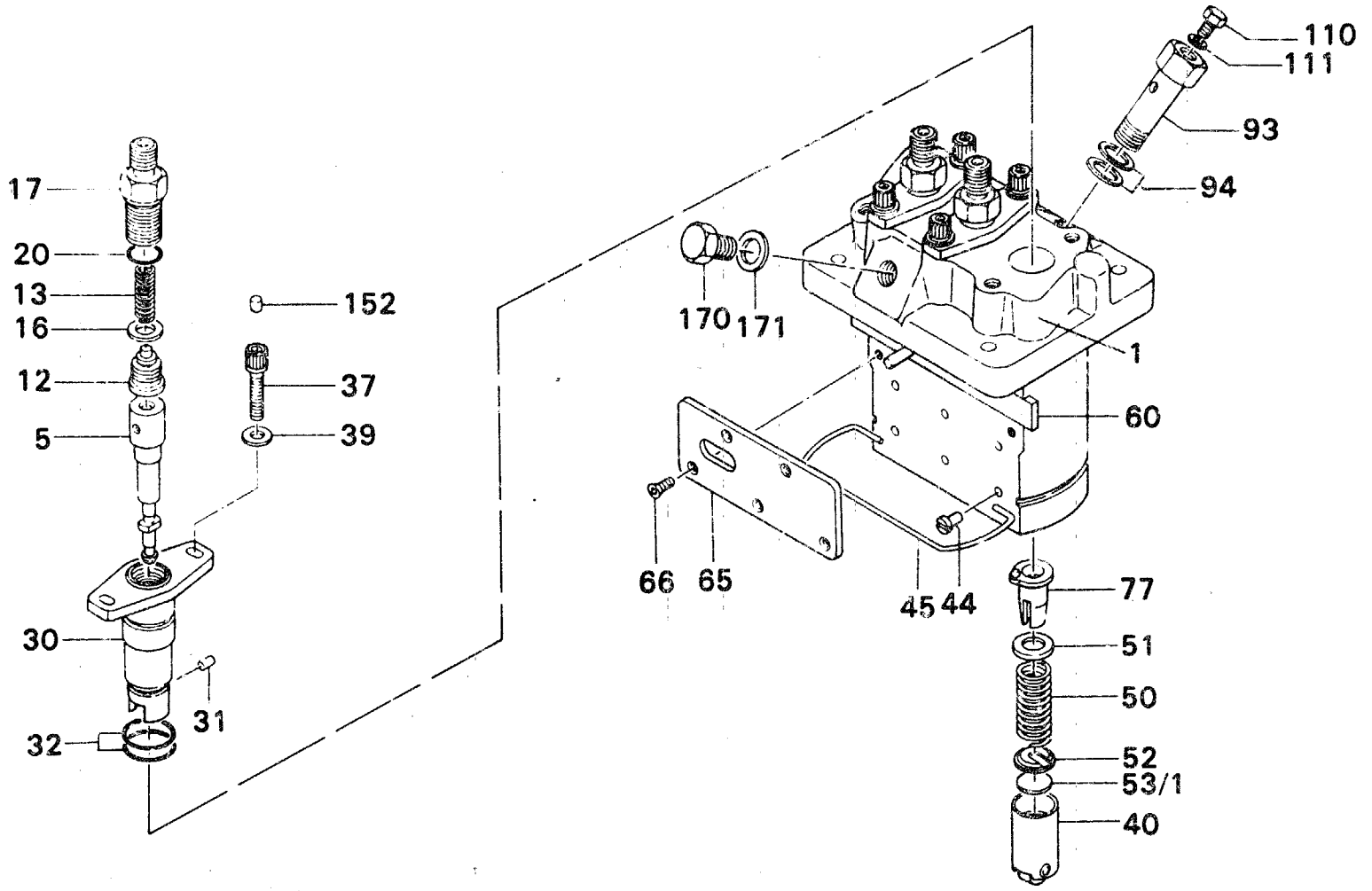

Fig. 31 Exploded view of PFR 3-MD pump

1 = Pump housing
5 = Plunger assembly
12 = Delivery valve assembly
13 = Delivery valve spring
16 = Gasket
17 = Delivery valve holder
20 = O-ring
30 = Sleeve flange
31 = Pin
32 = O-ring
37 = Socket head bolt
39 = Washer
40 = Tappet assembly
44 = Pin
45 = Snap ring
50 = Plunger spring
51 = Spring seat
52 = Spring seat
53 = Plate
60 = Control rod
65 = Plate
66 = Screw
77 = Control sleeve
93 = Eye bolt
94 = Gasket
110 = Bolt
111 = Gasket
152 = Plug
170 = Bolt
171 = Gasket

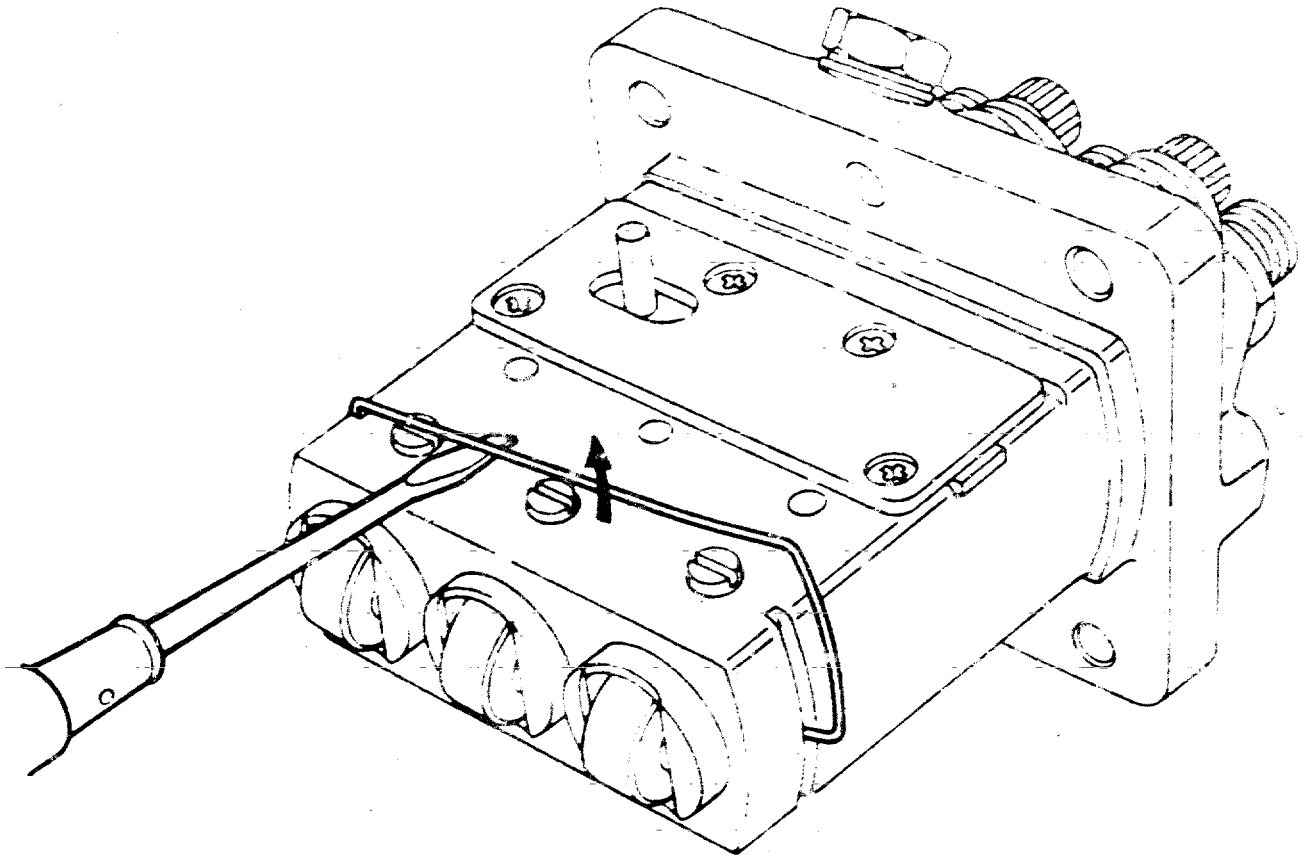

Fig. 32 Removing snap ring

1. Remove the snap ring (45) from the pump housing.

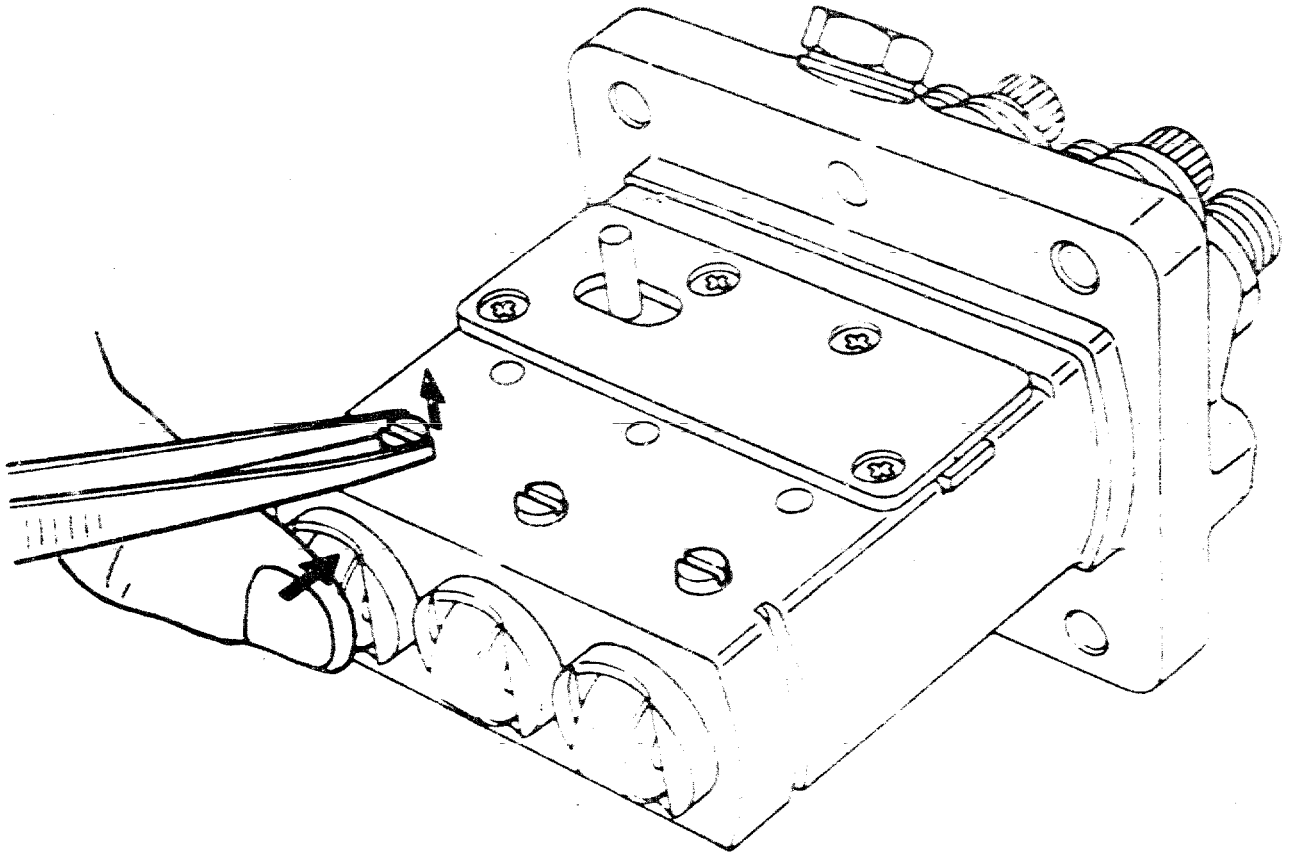

Fig. 33 Removing pin

2. Press the tappet (40) and remove the pin (44).

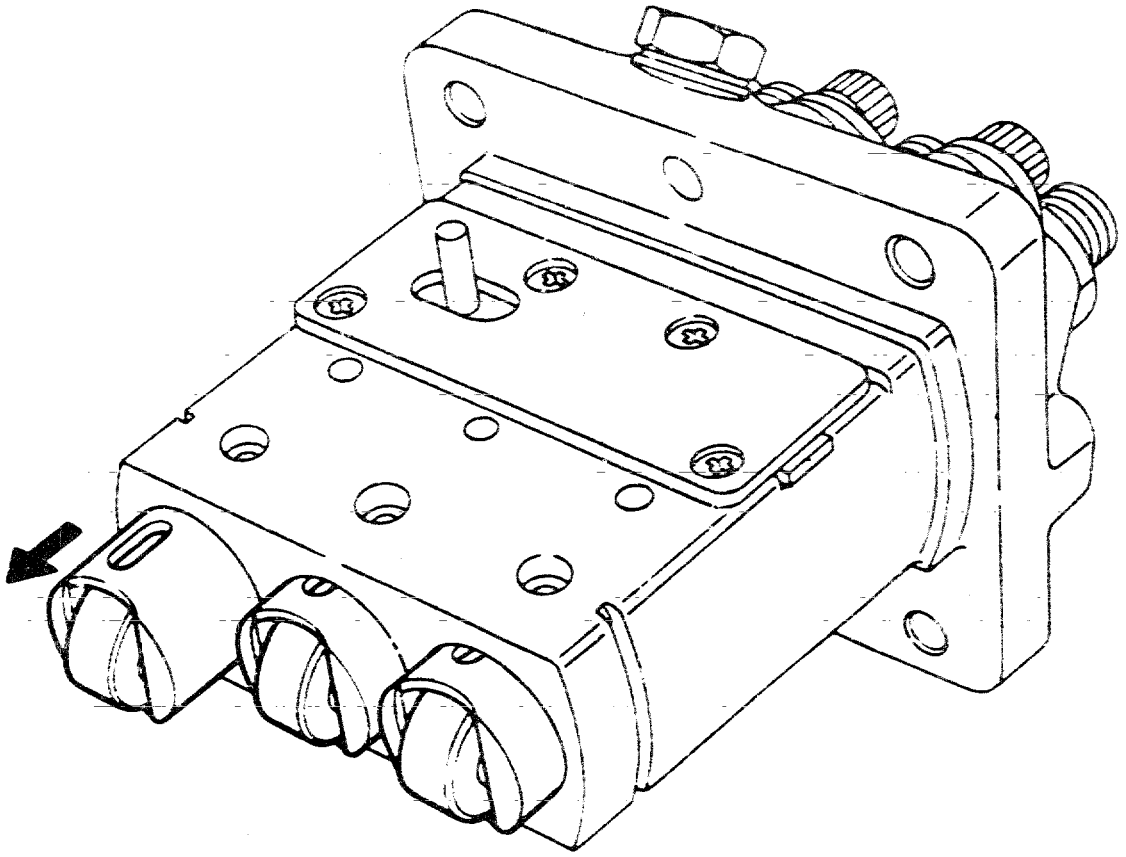

Fig. 34 Removing tappet and plate

3. Remove the tappet and plate (53) together.

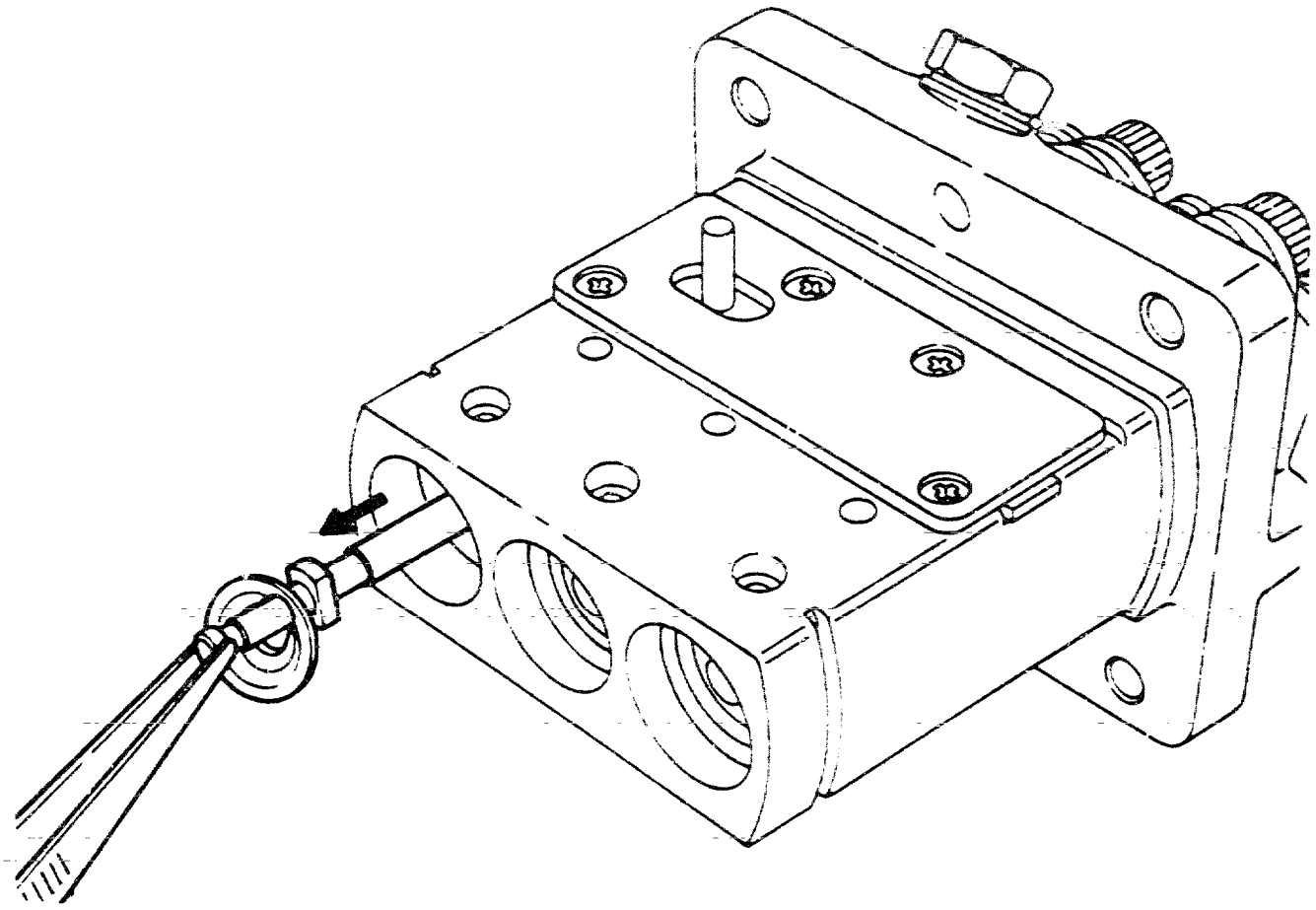

Fig. 35 Removing plunger and spring seat

4. Remove the plunger (5) and spring seat (52).

Note: Put plungers into clean fuel oil in the order of the cylinder numbers.

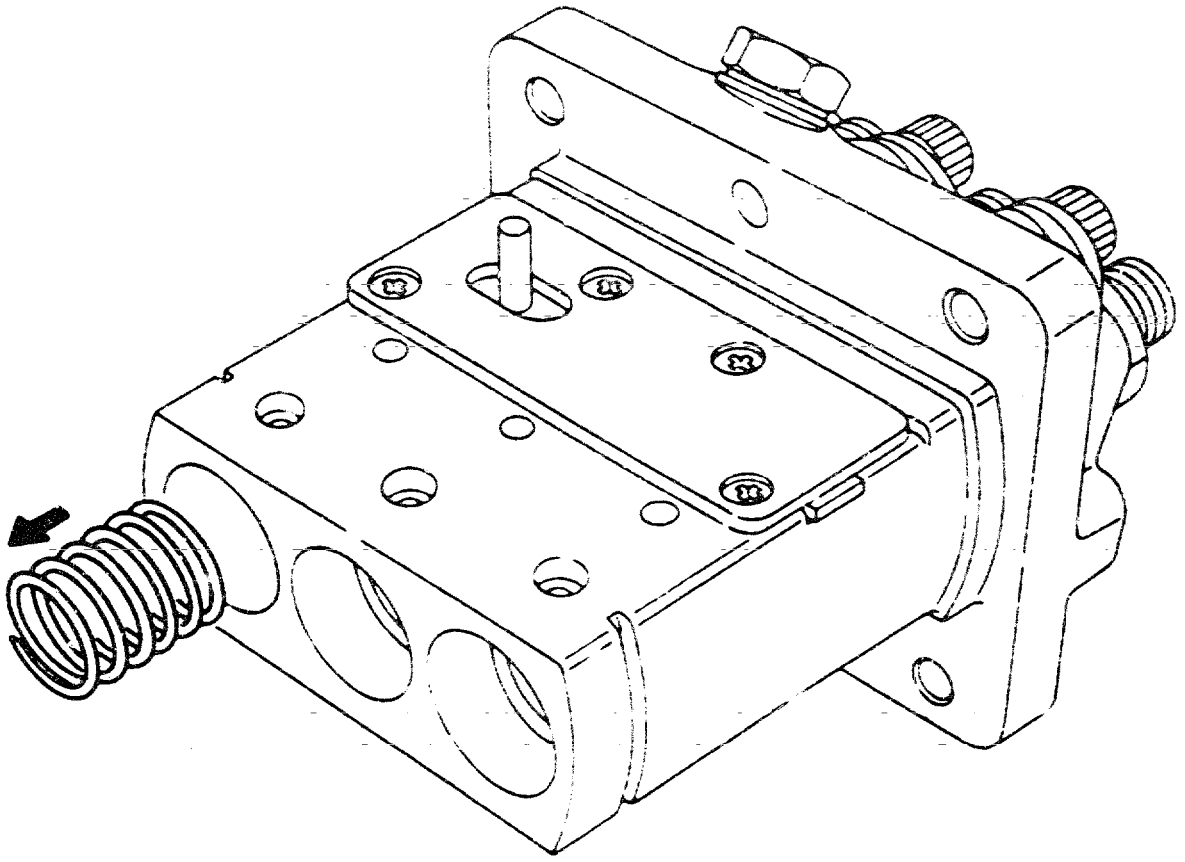

Fig. 36 Removing plunger spring

5. Remove the plunger spring (50).

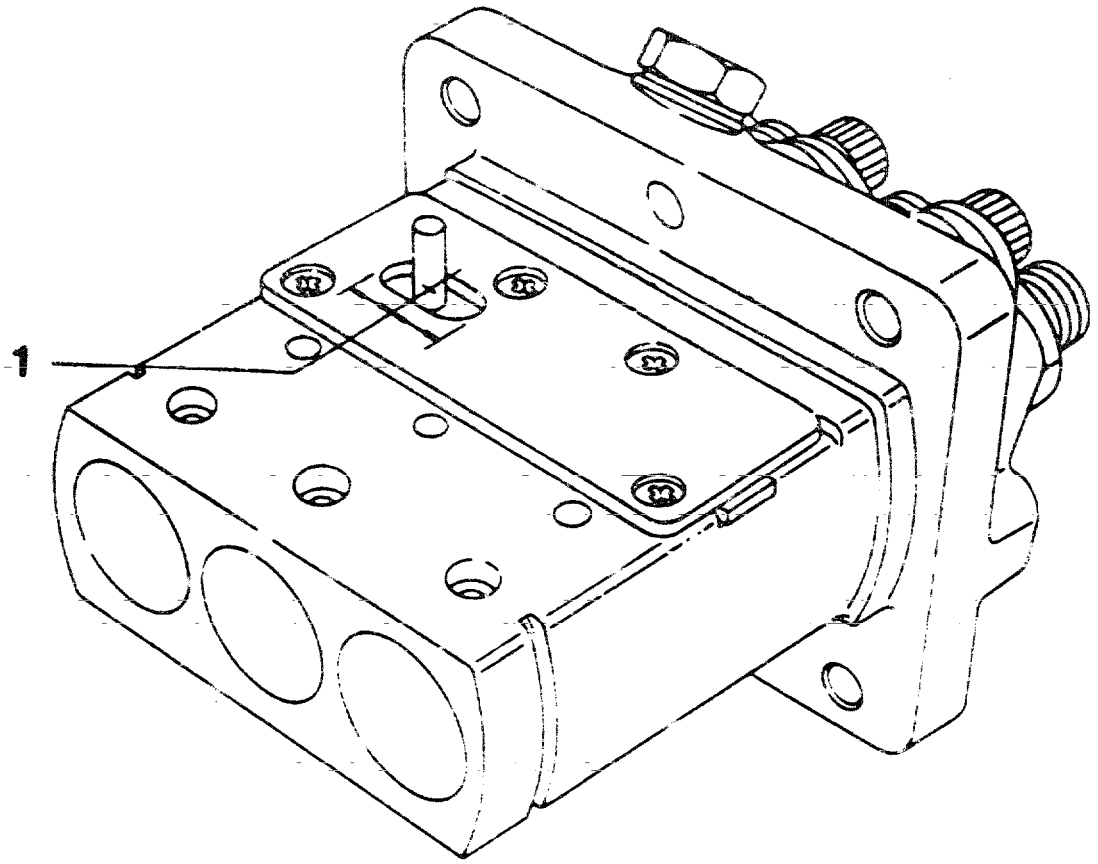

Fig. 37 Centering control rod

1 = Pin

6. Move the pin, press-fitted into the control rod (60), to the center of the plate groove (65).

Note: Unless the control rod is positioned in the center, the control sleeve cannot be removed.

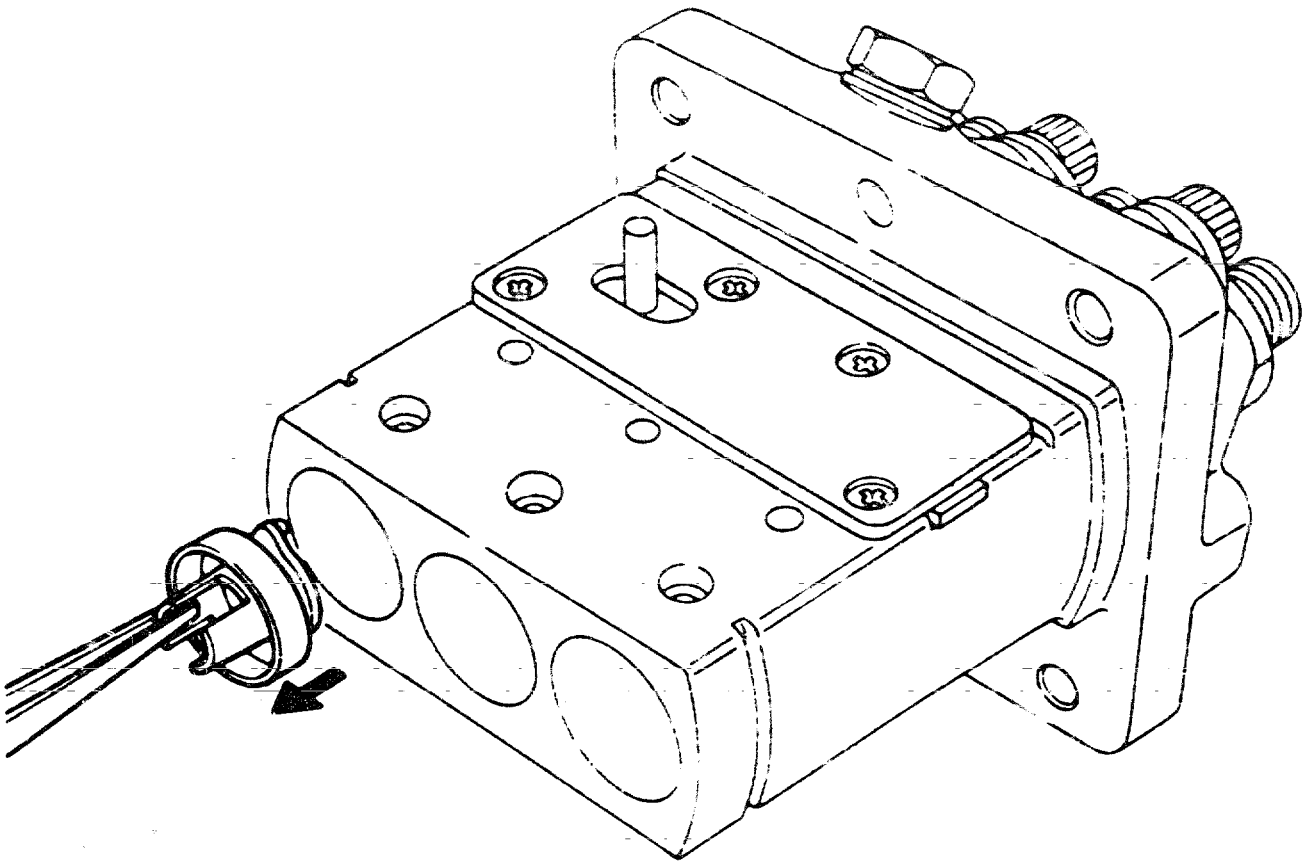

Fig. 38 Removing control sleeve and spring seat

7. Remove the control sleeve (77) and spring seat (51) together.

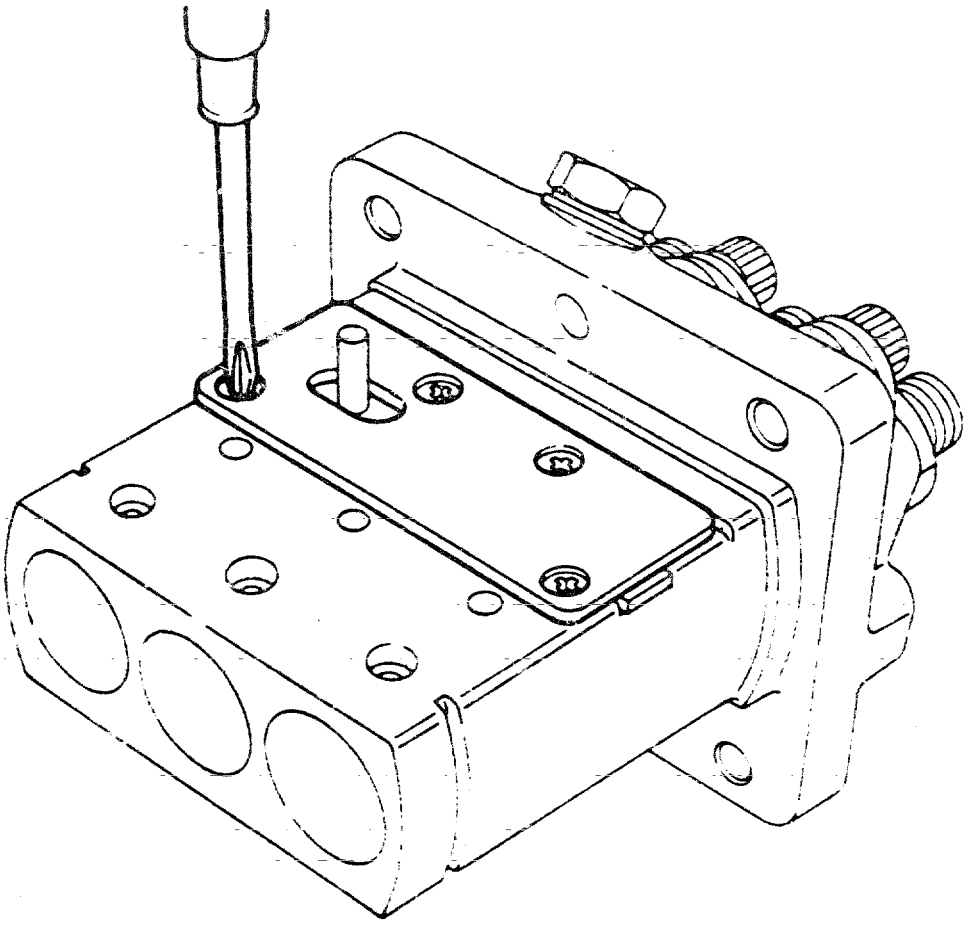

Fig. 39 Removing screws

8. Remove the four screws fixing the plate.
9. Remove the plate.

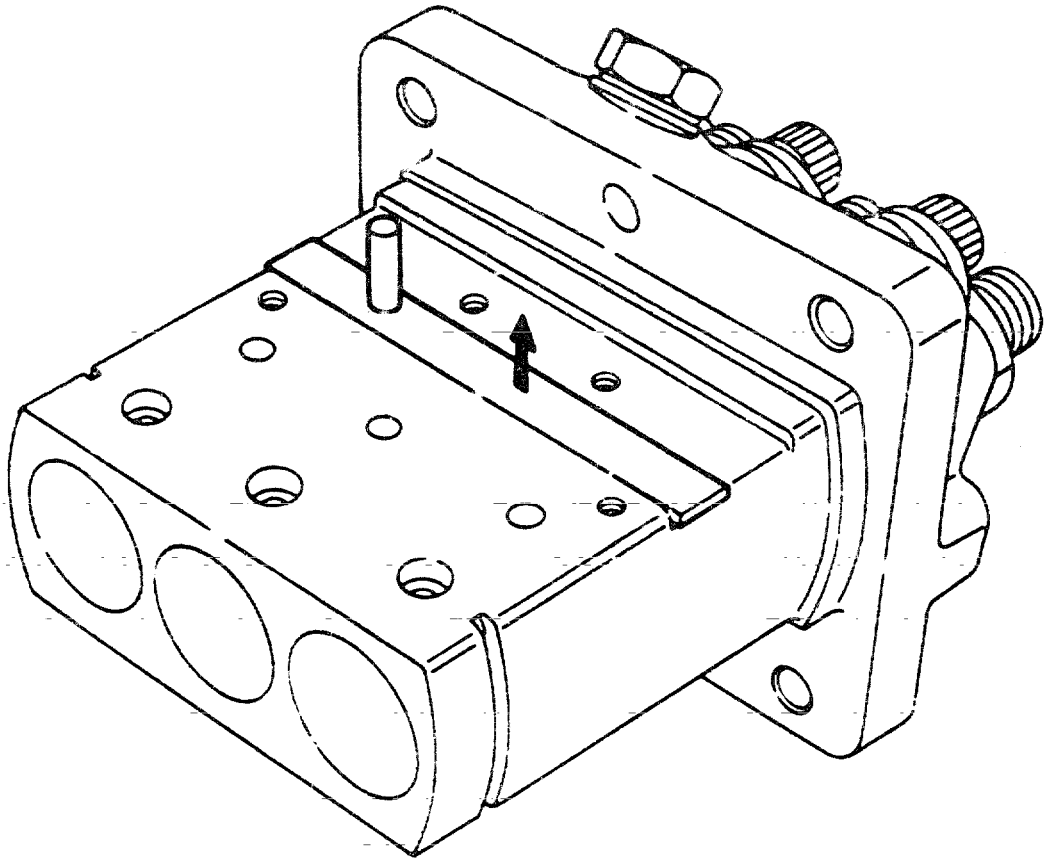

Fig. 40 Removing control rod

10. Remove the control rod.

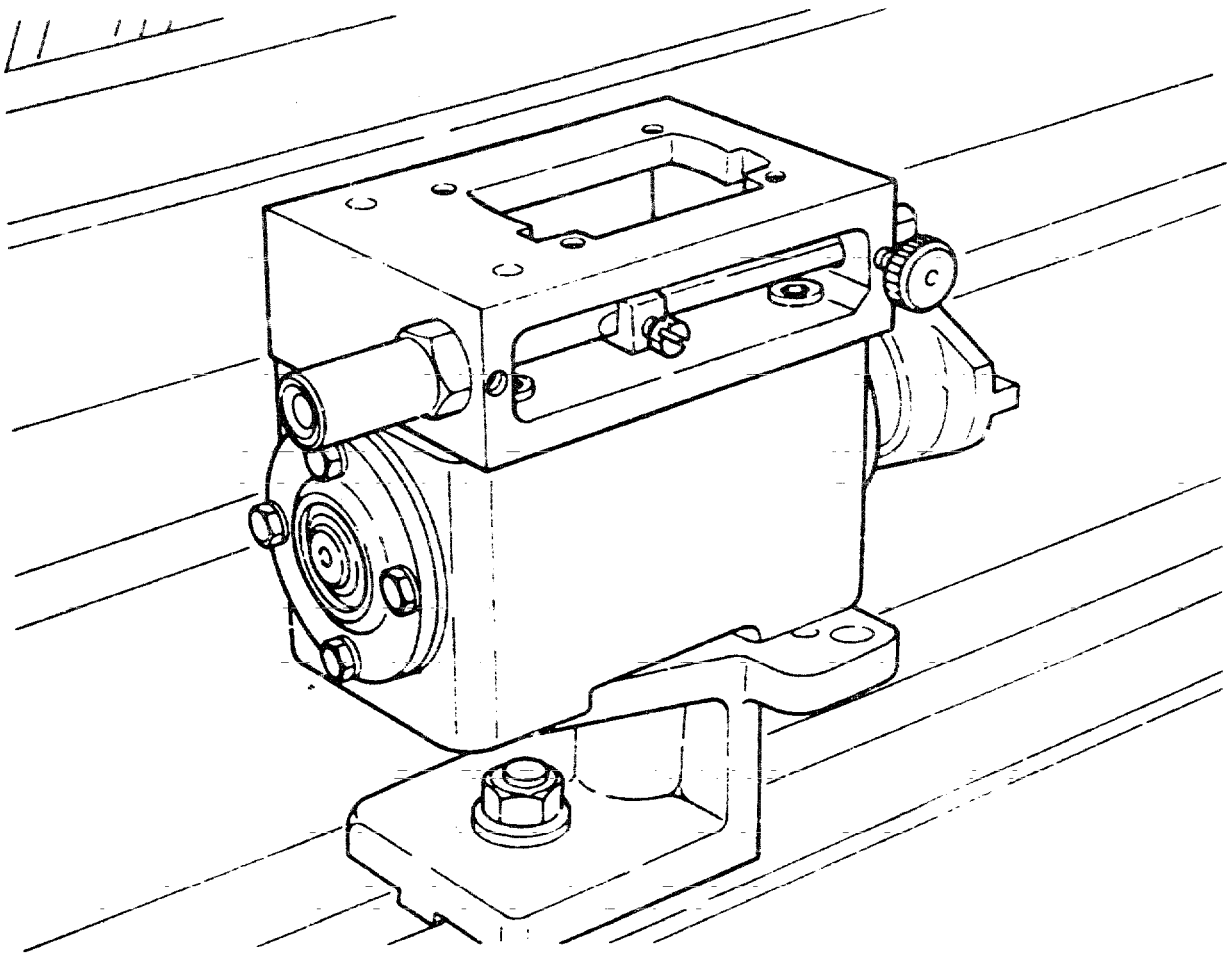

Fig. 41 Mounting driving stand

11. Mount the driving stand (part No. KDDC 0007) on the pump test stand.

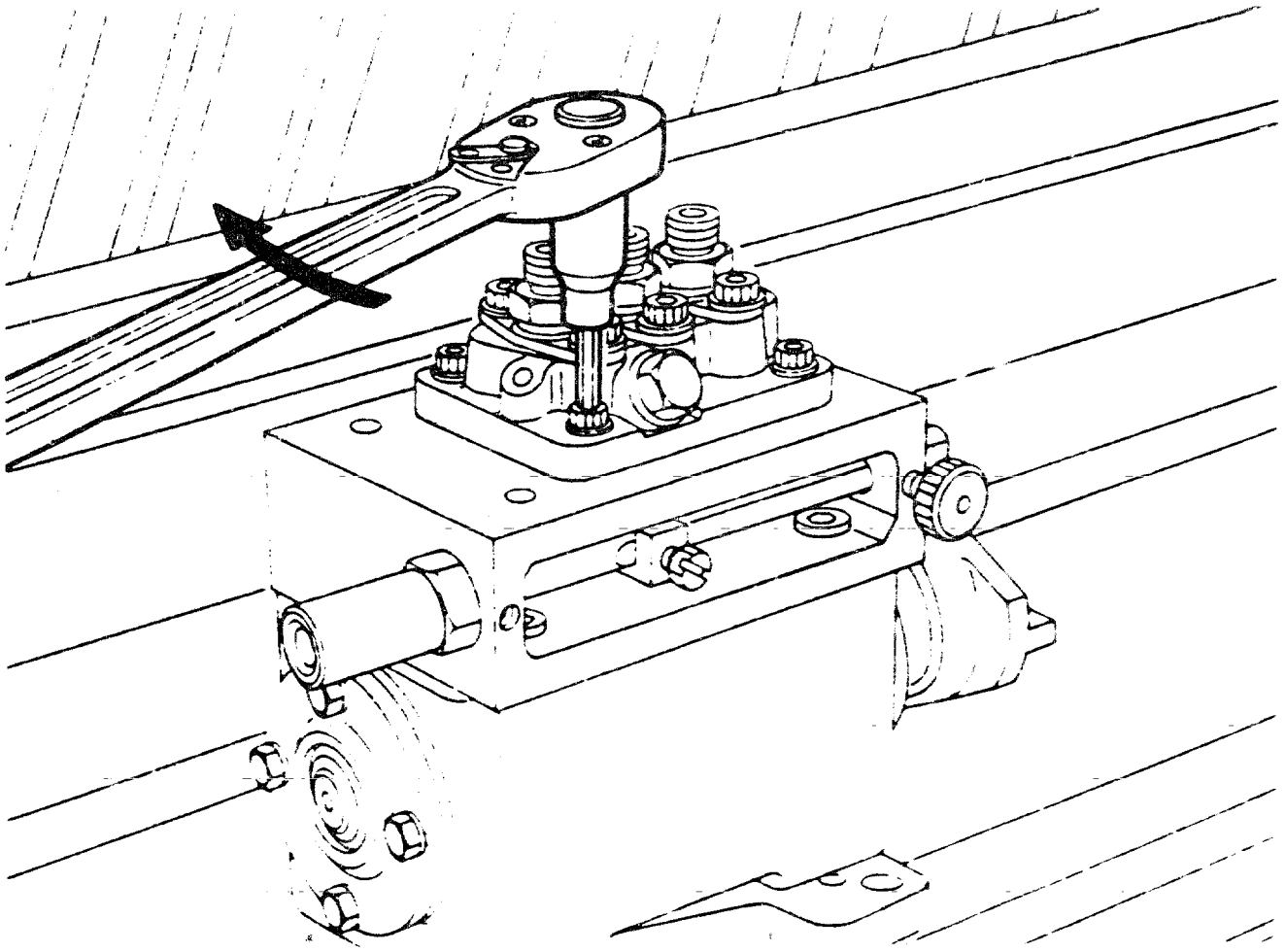

Fig. 42 Mounting injection pump

12. Mount the injection pump on the driving stand.

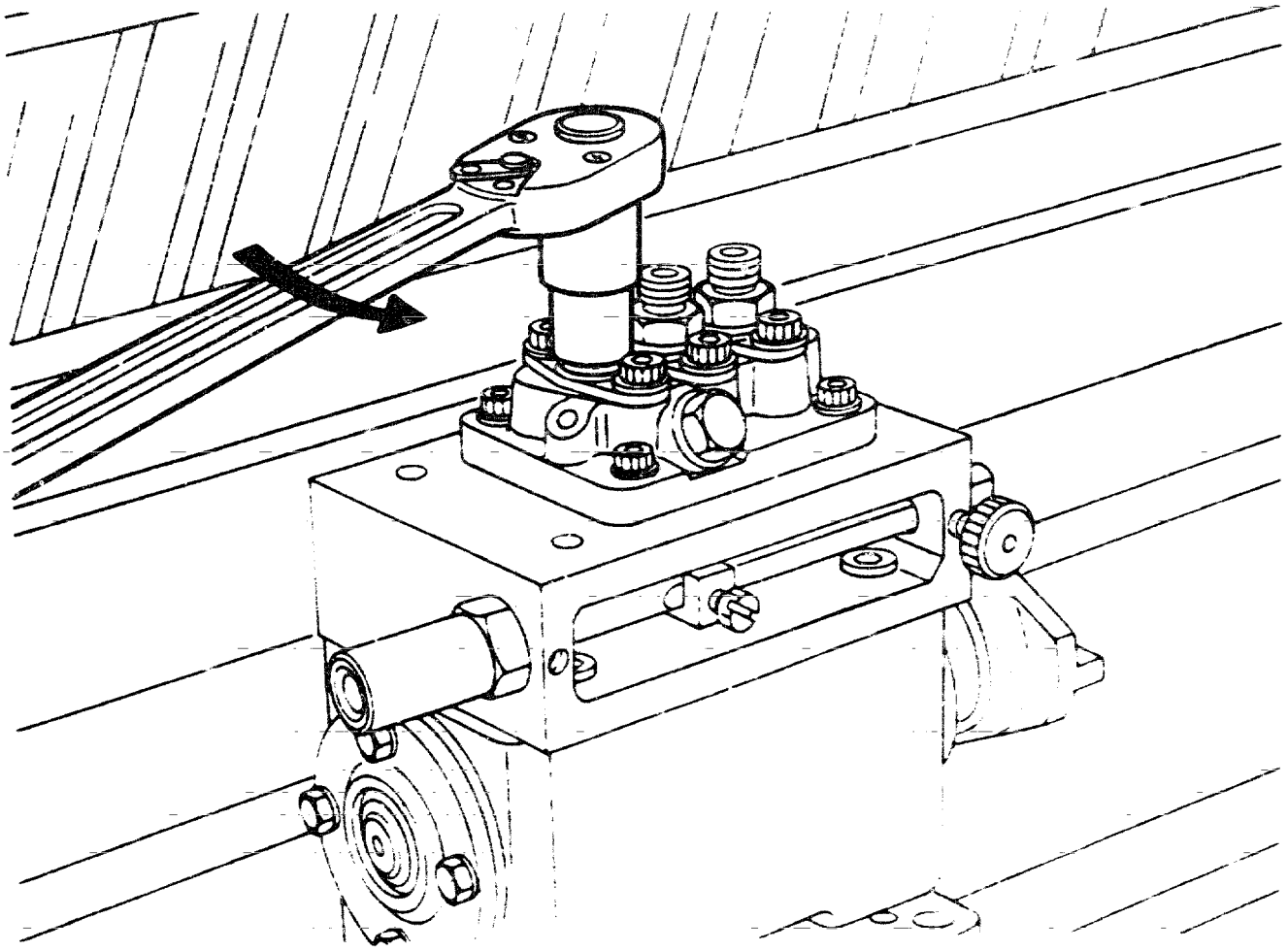

Fig. 43 Loosening delivery valve holder

13. Using a wrench, loosen the delivery valve holder (17).

Note: If the outside diameter of the wrench is greater than 22 mm, the wrench cannot be used because of interference with the other delivery valve holders.

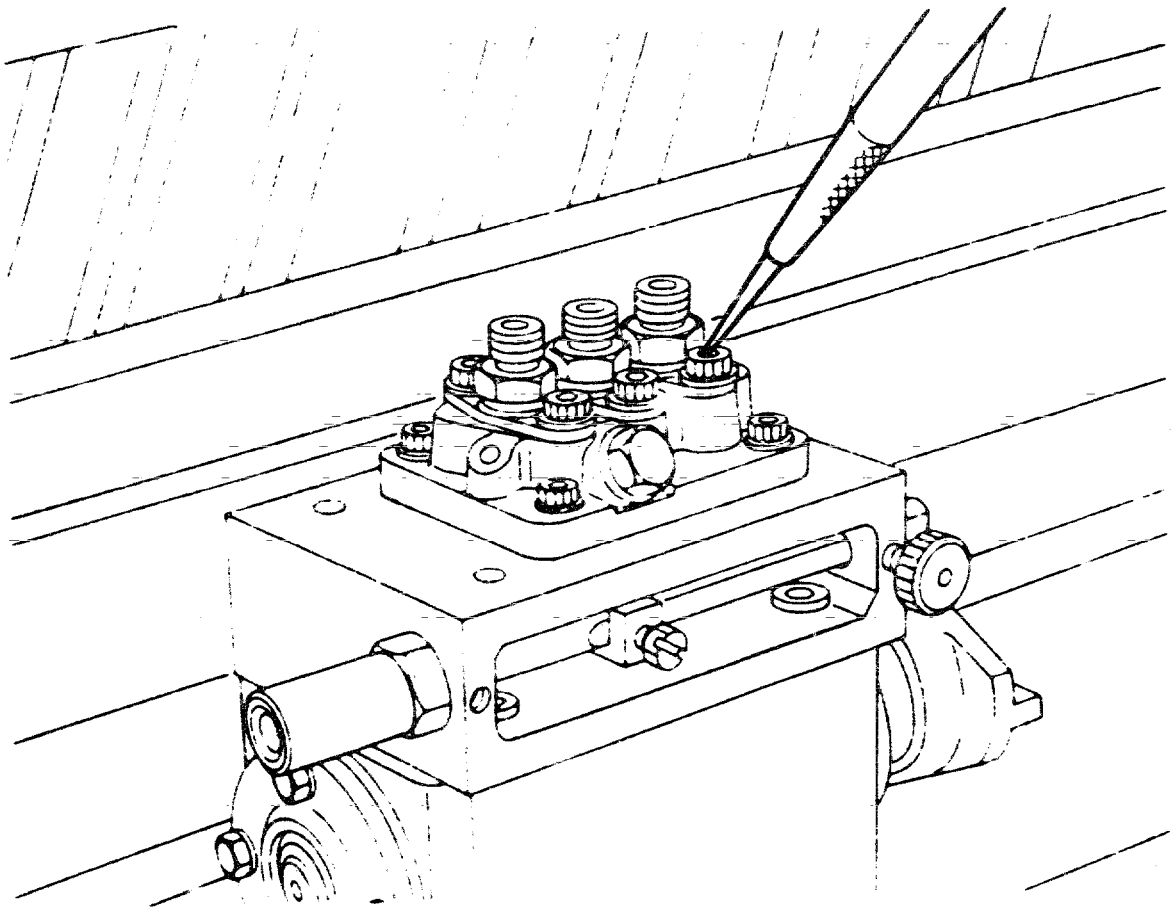

Fig. 44 Removing plug

14. Remove the plug (152) fitted to the hexagonal hole in the socket head bolt (37).

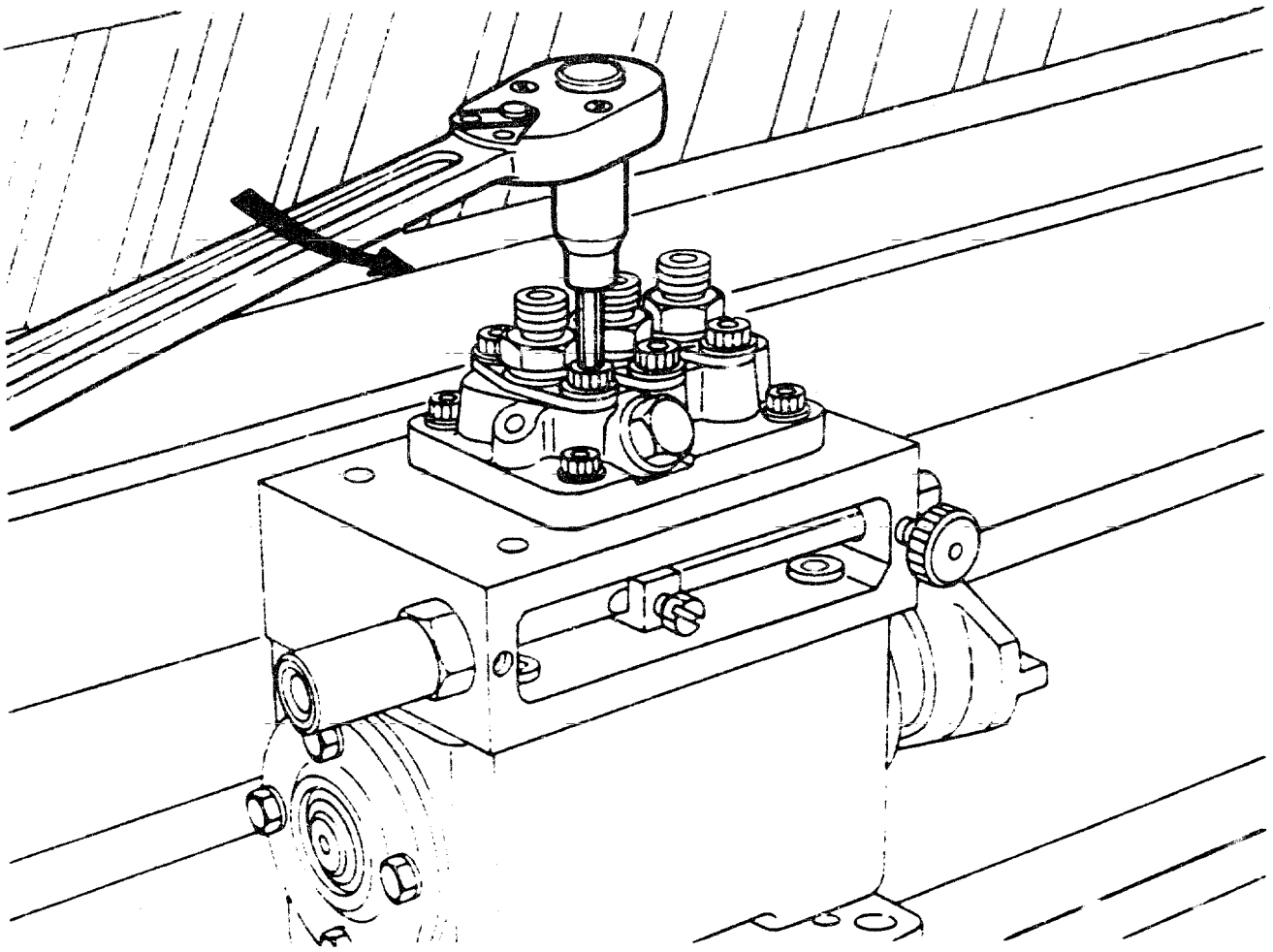

Fig. 45 Removing socket head bolt

15. Using a wrench, remove the socket head bolt.

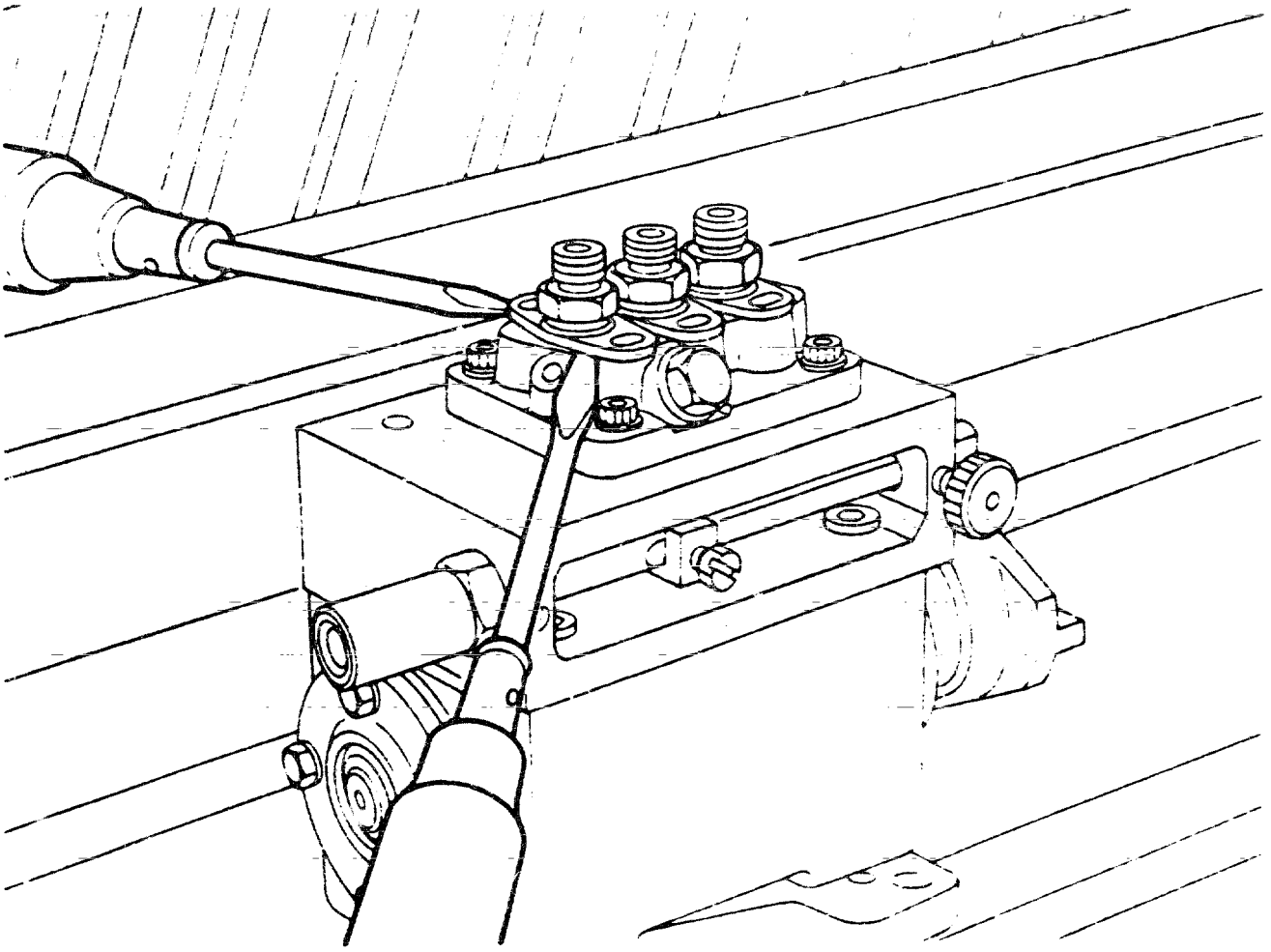

Fig. 46 Removing sleeve flange

16. Insert a screwdriver between the sleeve flange (30) and pump housing, and lift and remove the sleeve flange. This must be done carefully so that the pin (31) will not be dropped and lost.

Note: Do not damage the pump housing.

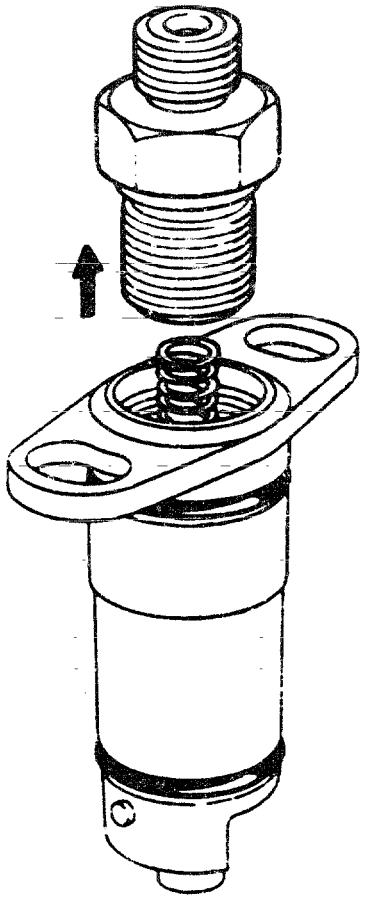

Fig. 47 Removing delivery valve holder

17. Remove the delivery valve holder from the sleeve flange.

18. Remove the delivery valve spring (13).

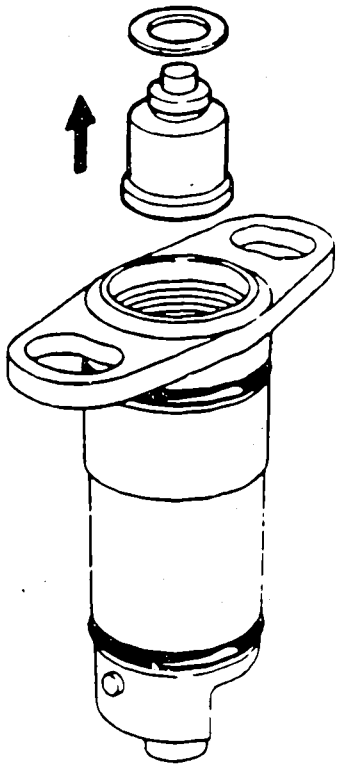

Bild 48 Druckventilträger mit Druckventil und Dichtung ausbauen

19. Druckventilträger (12) mit Druckventil und Dichtung (16) zusammen herausnehmen.

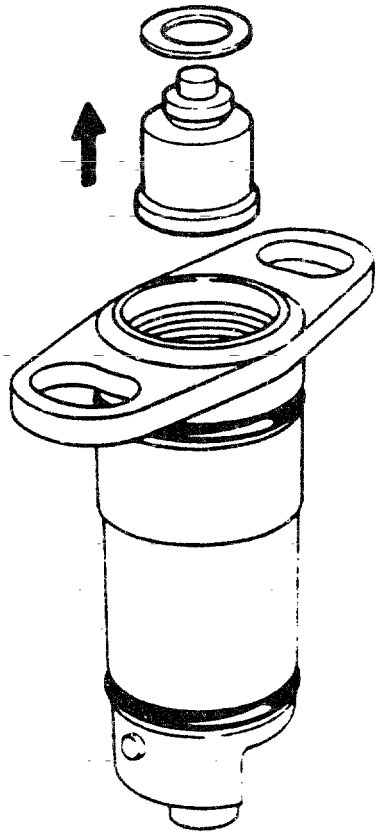

Fig. 48 Removing delivery valve assembly and gasket

19. Remove the delivery valve assembly (12) and gasket (16) together.

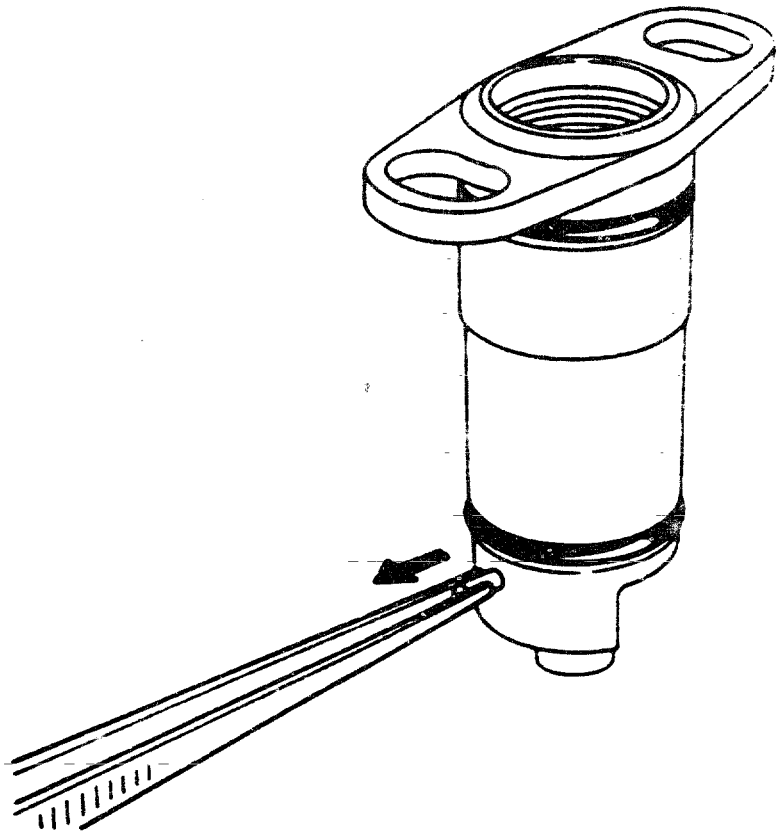

Fig. 49 Removing pin

20. Remove the pin (31) from the sleeve flange.

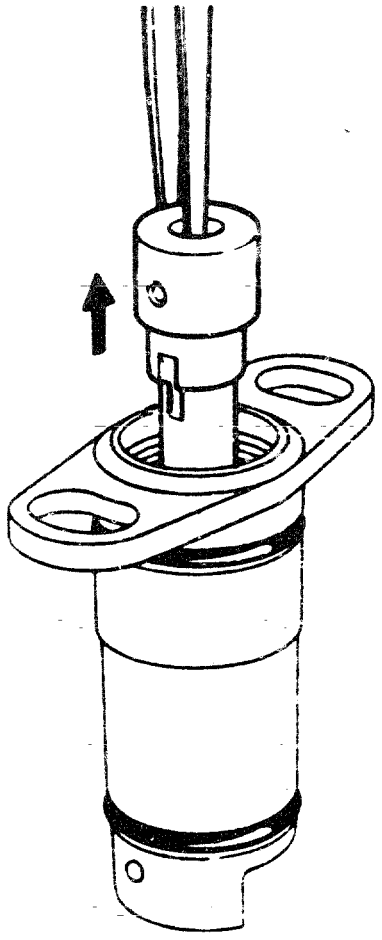

Fig. 50 Removing plunger barrel

21. Remove the plunger barrel (5) from the sleeve flange and attach the plunger barrel to the previously removed plunger. Put them into clean fuel oil.

Caution: Do not attach the plunger barrel to a different plunger.

22. Finally, remove six O-rings (32). Disassembly of the PFR3MD pump is thus completed.

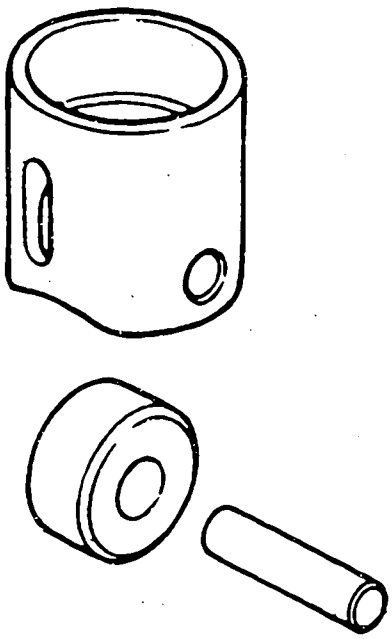

Bild 51 Rollenstößel, Rolle und Lagerbolzen

PRÜFUNG

Pumpengehäuse

Ist das Pumpengehäuse gerissen, abgenutzt oder weist es beschädigte Gewinde auf, so muß es ersetzt werden.

Rollenstößel

Ist die Zylinderfläche des Rollenstößels, die Rolle oder der Lagerbolzen der Rollen rissig bzw. zeigen diese Teile starken Verschleiß, Abschälung, Überhitzungsspuren oder Anzeichen von Fressen auf, so ist der Rollenstößel auszuwechseln.

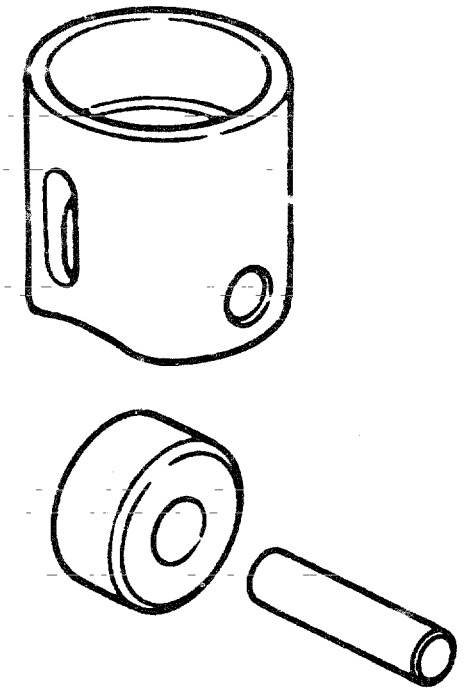

Fig. 51 Tappet, roller and roller pin

INSPECTION

Pump Housing

If the pump housing is cracked, worn or has damaged threads, it must be replaced.

Tappets

If the tappet perimeter, roller or roller pin is flawed, shows excessive wear, peeling, burning or a tendency to burn, replace the tappet.

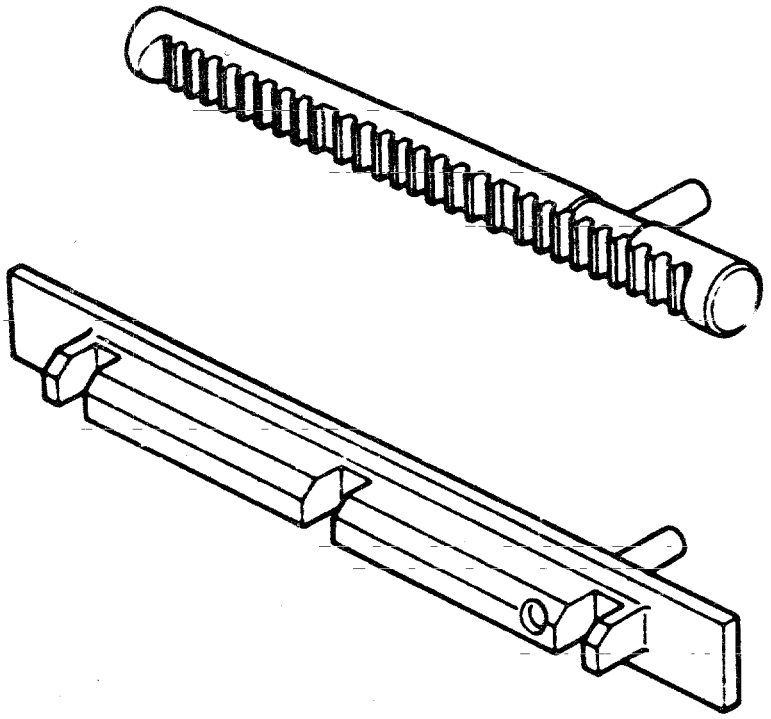

Fig. 52 Control rack and control rod

Control Rack (or rod)

If the control rack (or rod) is bent, dented or shows excessive wear on the teeth (in PFR·KD pump) or groove (in PFR·MD pump), replace the control rack (or rod).

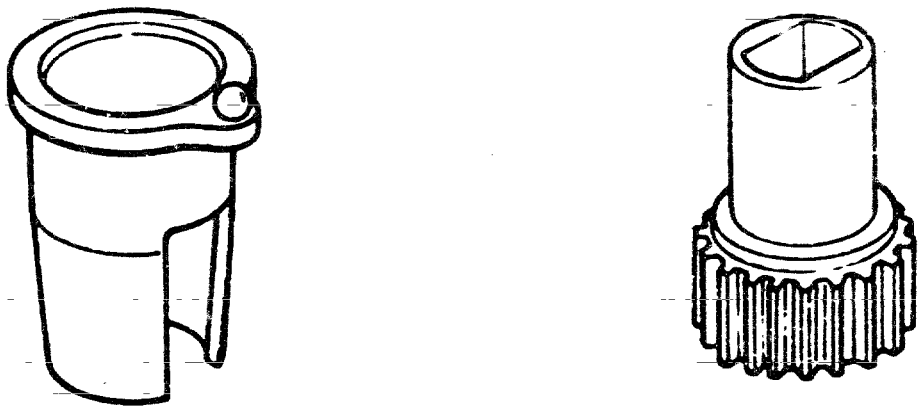

Fig. 53 Control sleeve

Control Sleeve

If the ball (in PFR•MD pump), teeth (in PFR•KD pump) or groove (fitting the plunger flange) is excessively worn, replace the control sleeve.

Bild 53 Regelhülse

Regelhülse

Ist die Kugel (PFR-MD-Pumpe), die Verzahnung (PFR-KD-Pumpe) oder der Führungsschlitz (für die Kolbenfahne) stark abgenutzt, so ist die Regelhülse auszuwechseln.

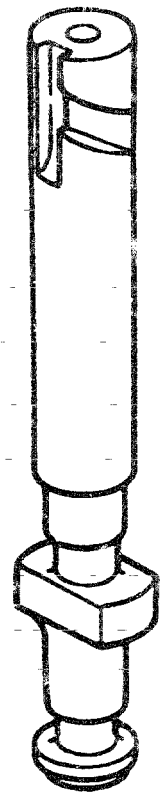

Fig. 54 Plunger helix

Plunger Assembly

1. If the plunger helix is flawed, discolored or worn, replace the plunger assembly.

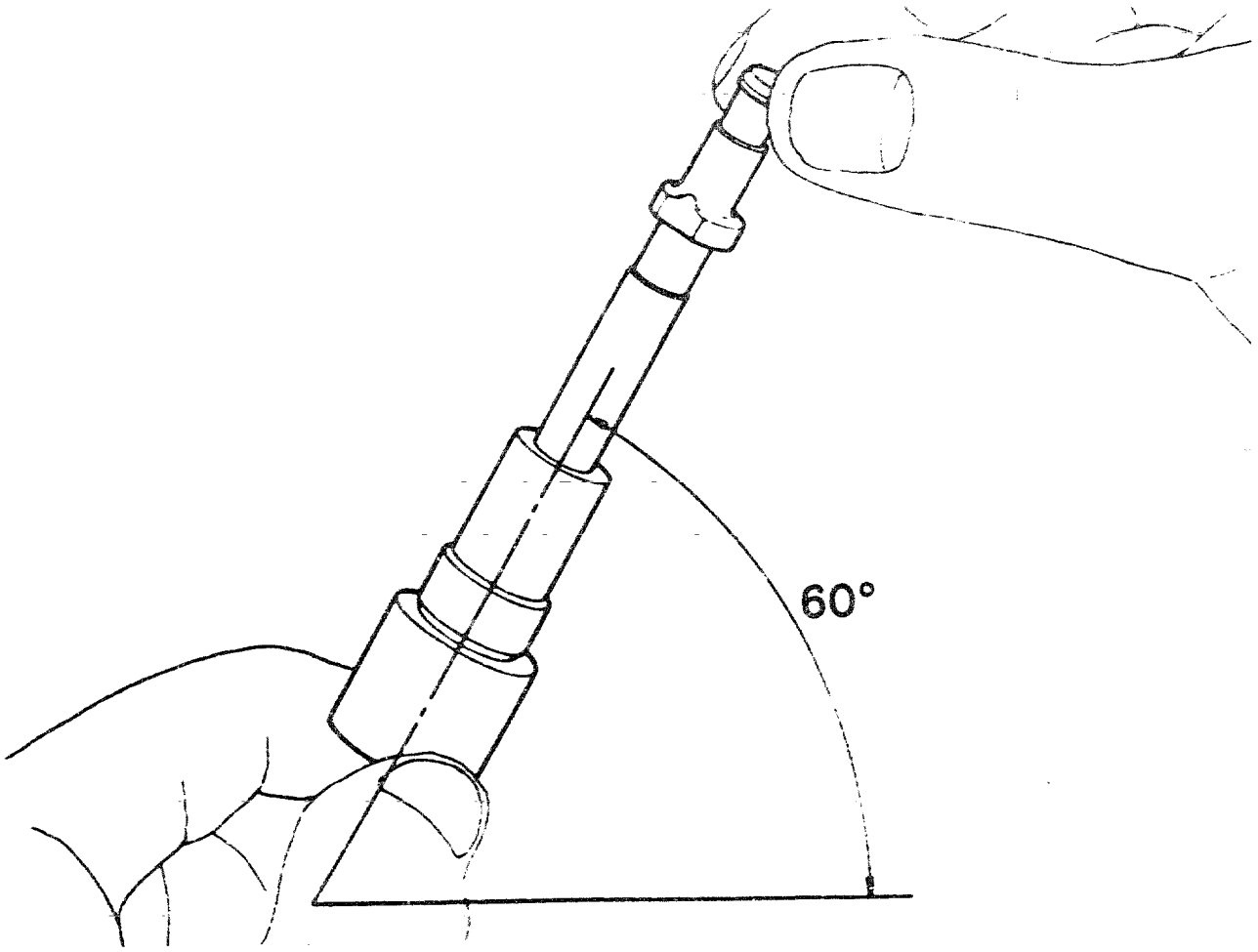

Fig. 55 Plunger inspection

2. After the plunger assembly has been washed well in clean fuel oil, tilt the plunger assembly approximately 60 degrees, as shown in Fig. 55. If the plunger slides down smoothly inside the plunger barrel, under its own weight, the condition of the plunger assembly is satisfactory. During this test, turn the plunger several times. If the plunger stops midway or it slides down too fast, replace the plunger assembly.

Fig. 56 Delivery valve piston function inspection

Delivery Valve

1. If the piston or seat is flawed, dented or worn, replace the delivery valve assembly.

2. After the delivery valve assembly has been washed well in clean fuel oil, hold your finger on the bottom of the delivery valve body, as shown in Fig. 56. Then, press the delivery valve lightly with another finger. If the valve springs back when you release your finger, the condition of the delivery valve assembly is satisfactory. If the valve does not spring back, the piston is worn. Replace the delivery valve assembly.

Threads

If the threads of any part are damaged (i.e. fractured, distorted, etc.), repair or replace the part.

Gasket and O-rings

Replace all gaskets and O-rings when they are removed. Do not reuse.

Other Parts

Check each part carefully. If they are damaged or worn excessively, replace.

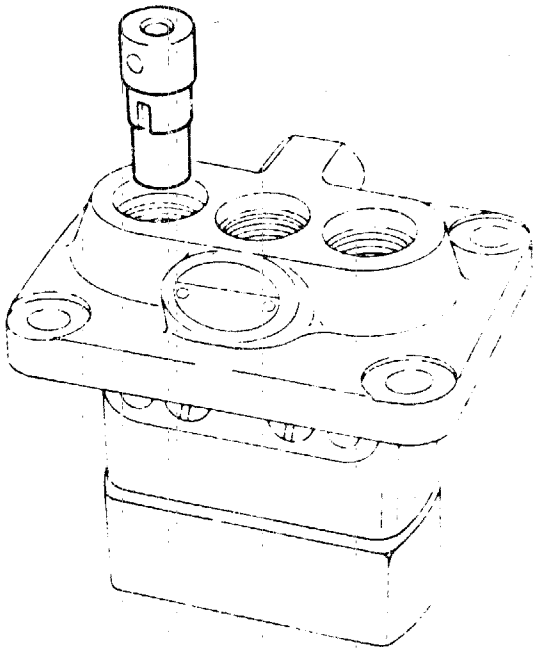

Fig. 57 Plunger barrel and eccentric pin

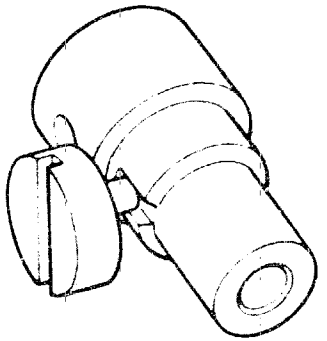

Fig. 58 Attaching plunger barrel

REASSEMBLY

Reassembly of the injection pump is performed in the reverse order of disassembly.
Special care must be taken on the following points:

PFR-KD Type Injection Pump

1. Attach the plunger barrel to the pump housing, checking that the end of the eccentric pin or guide pin fits the plunger barrel alignment groove.

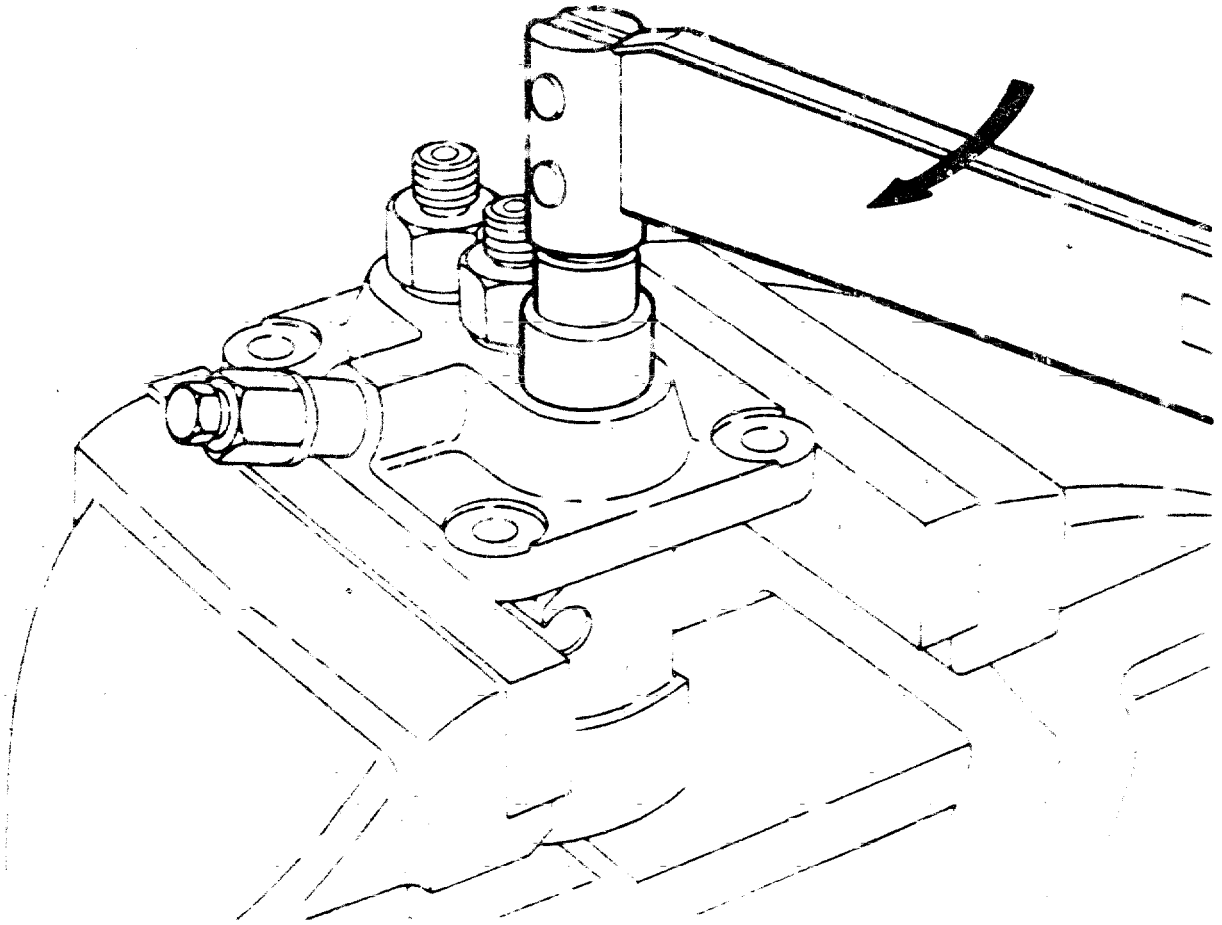

Fig. 59 Tightening delivery valve holder

2. Tighten the delivery valve holder to the specified torque.

   Specified tightening torque: 4 to 4.5 kg-m

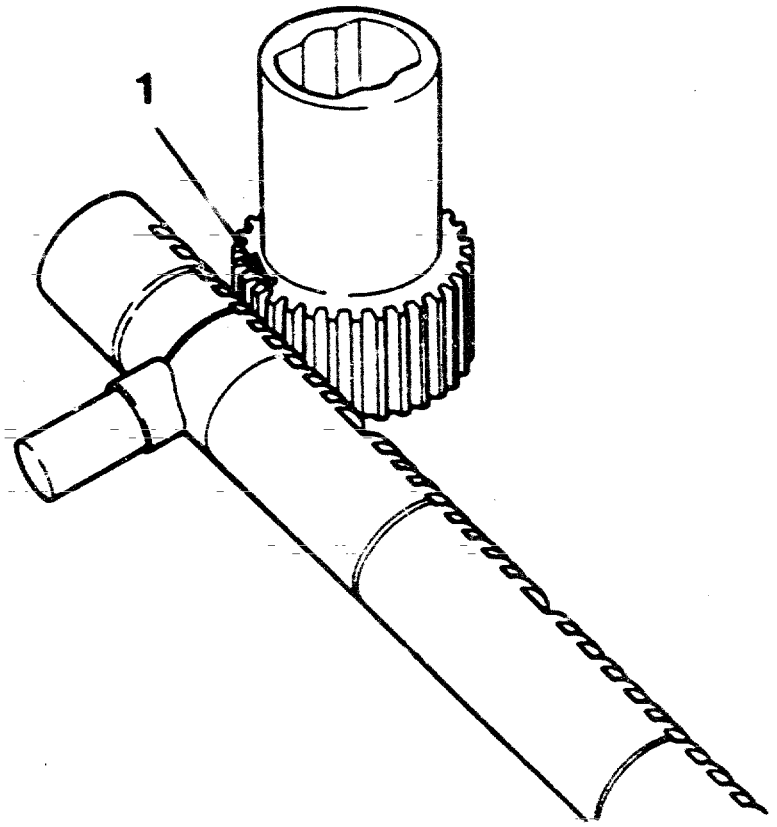

Fig. 60 Fitting the control sleeve to the control rack

1 = Punched mark

3. Fit the control sleeve to the control rack by aligning the marks (a line for the control rack and a punched mark for the control sleeve).

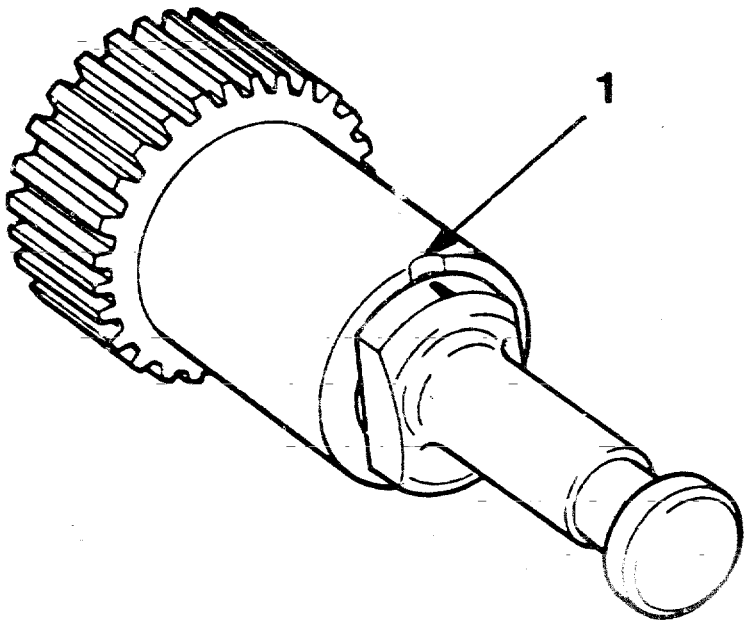

Fig. 61 Fitting the plunger

1 = V notch

4. When the plunger is inserted into the plunger barrel, align the line on the plunger with the V notch of the control sleeve. This is to ensure the plunger helix correctly aligns with the suction and discharge port of the plunger barrel.

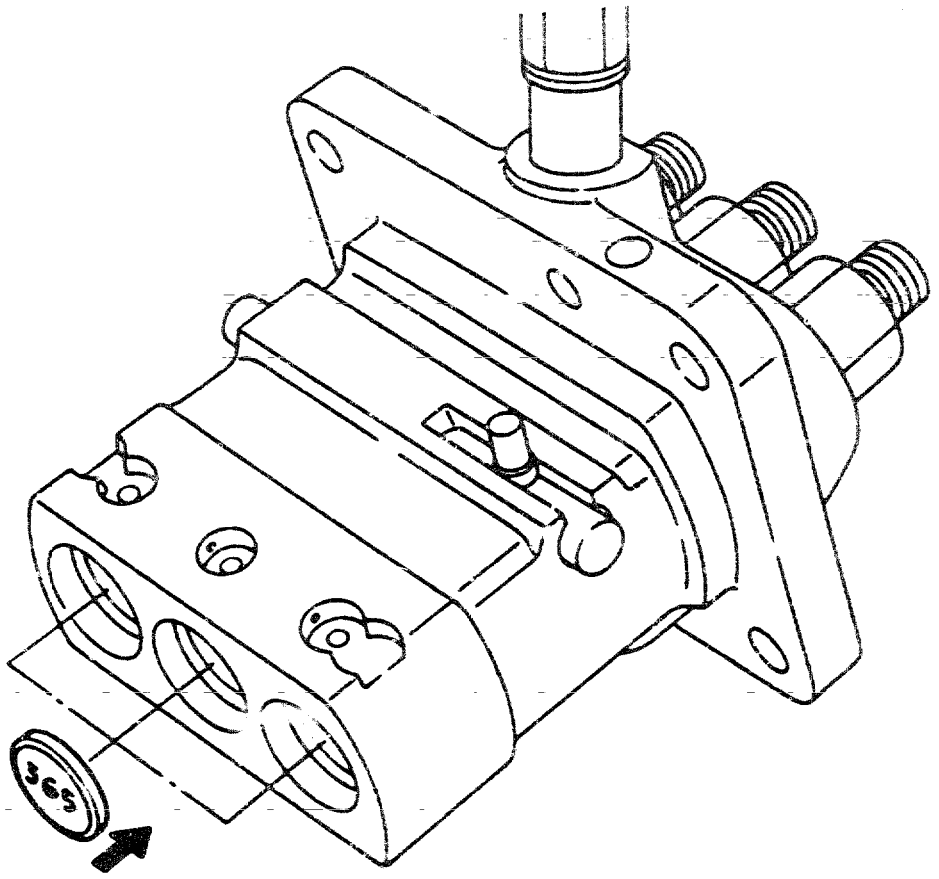

Fig. 62 Fitting the plate

5. Fit with the chamfered side of the plate facing the tappet side.

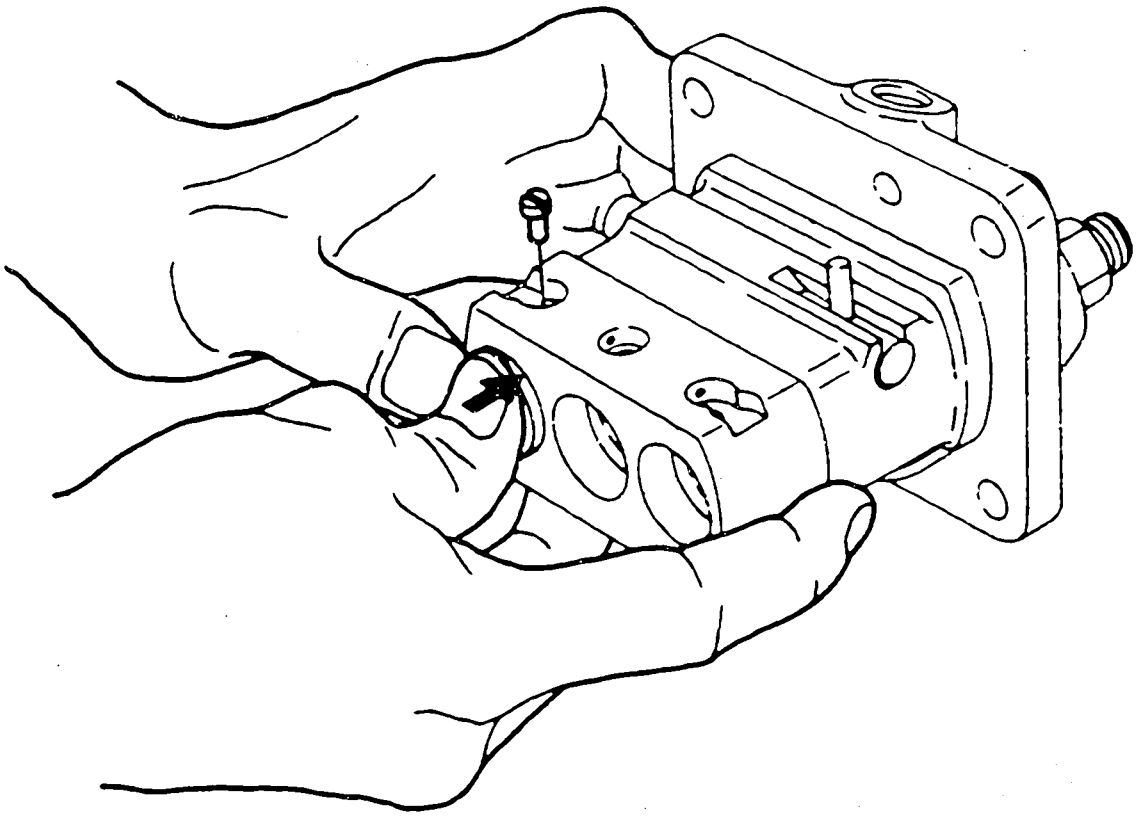

Bild 63 Rollenstößel einbauen

6. Nachdem der Bolzen (44) mit dem Rollenstößel in Eingriff gebracht ist, Regelstange langsam bewegen und Rollenstößel niederdrücken, bis die Kolbenfahne in den Schlitz der Regelhülse eingreift.

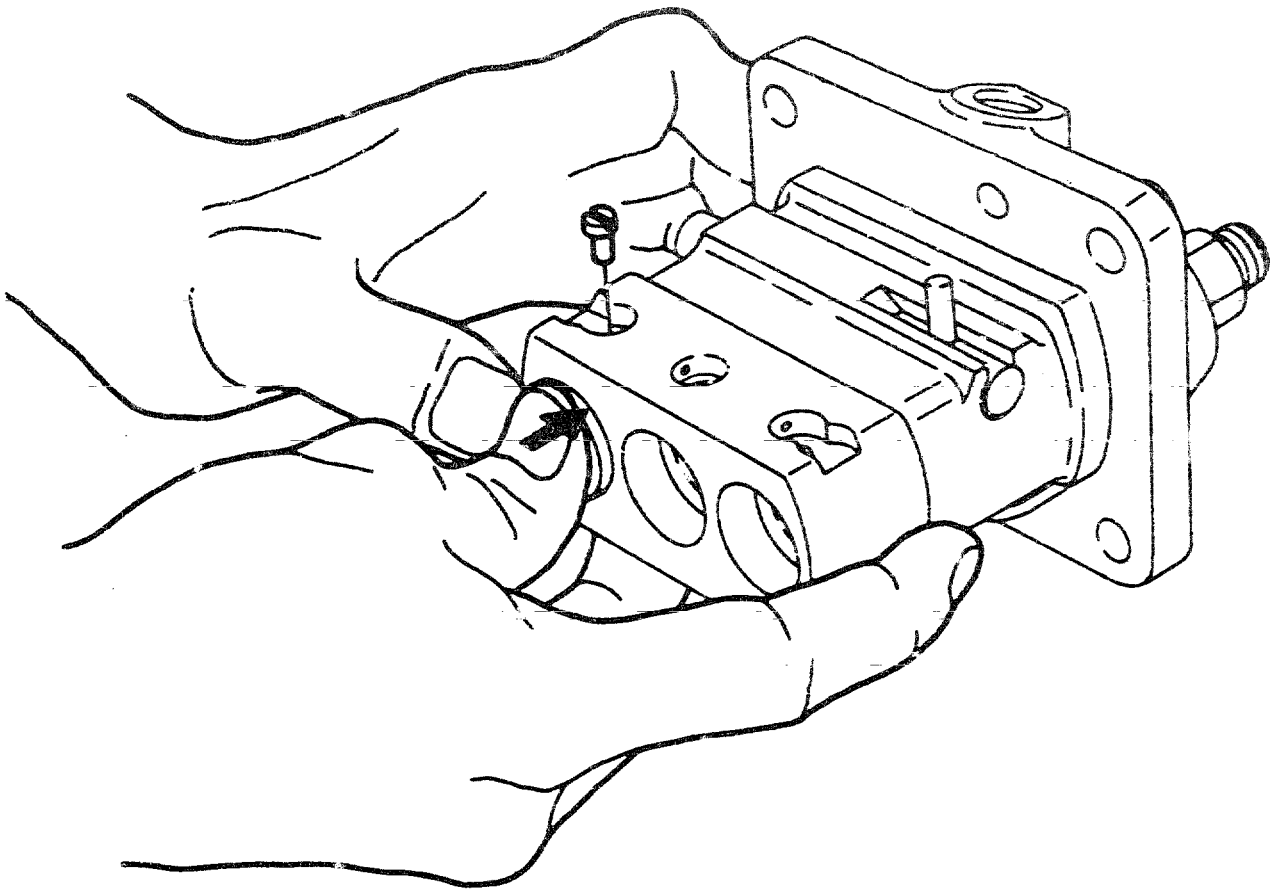

Fig. 63 Fitting tappet

6. When the pin (44) is inserted into the tappet, slowly move the control rack, pressing the tappet to find where the plunger flange fits the control sleeve groove.

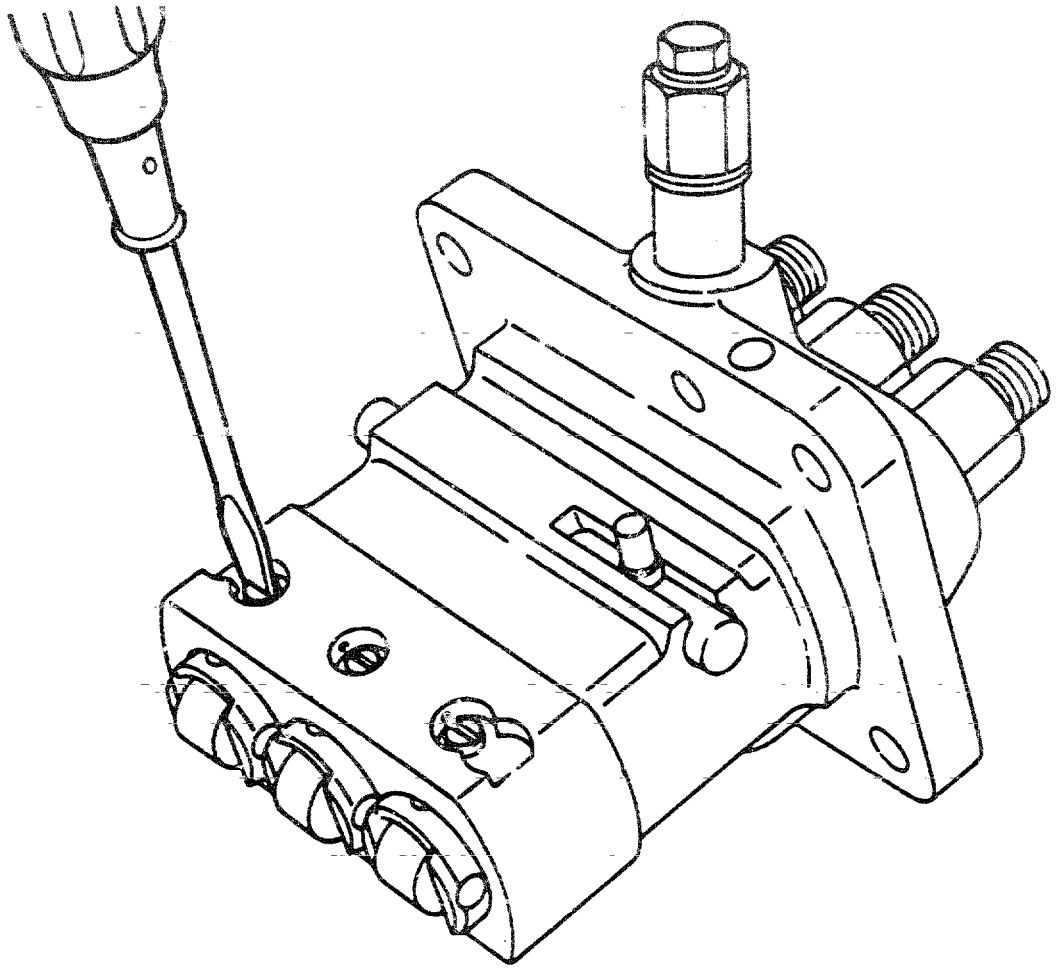

Fig. 64 Setting pin position

7. After the pin grooves are set horizontally with a screwdriver, attach the wire.

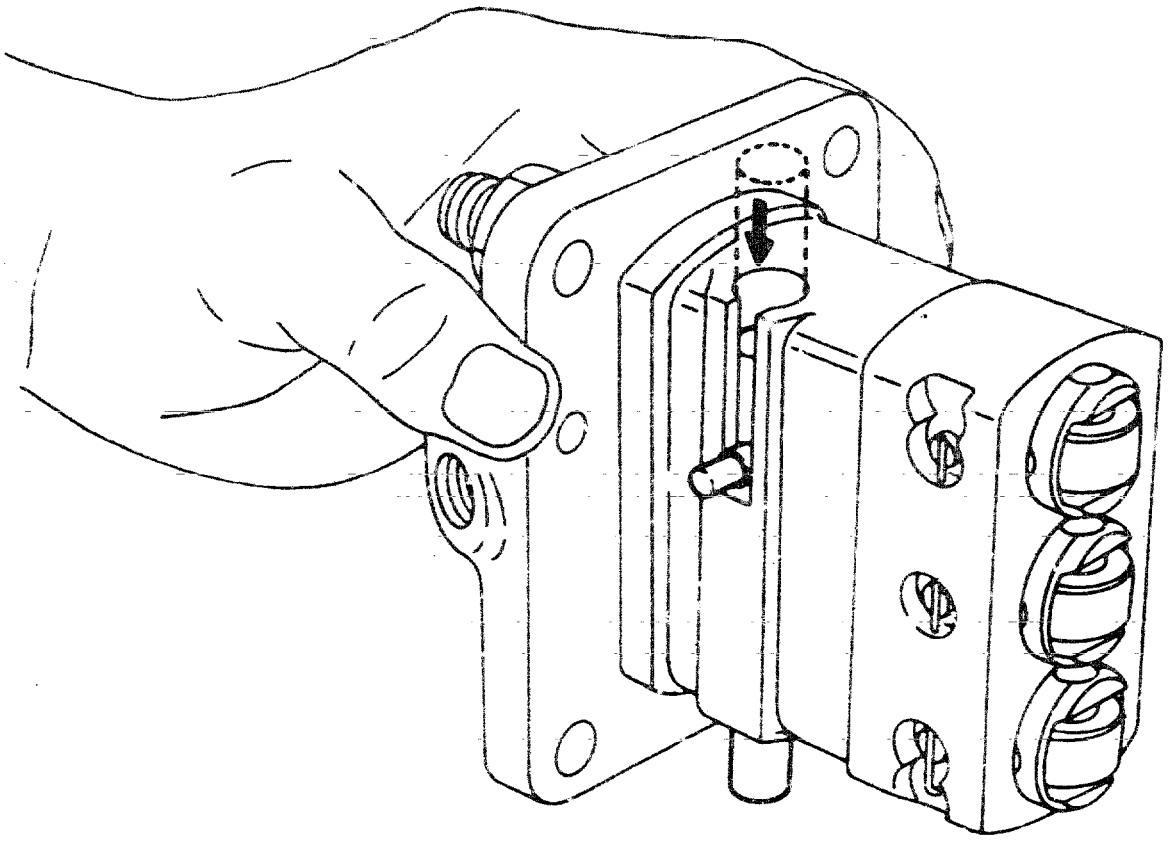

Fig. 65 Control rack movement inspection

8. After reassembly, tilt the injection pump as shown in Fig. 65 and check that the control rack slides under its own weight.
If the control rack does not move smoothly disassemble to find the cause.

1. After the plunger barrel is inserted into the sleeve flange, set the pin into the plunger barrel groove to position (to stop turning) the plunger barrel.

Note: To prevent the pin from slipping out, coat the pin with grease.

2. When the sleeve flange assembly is assembled with the pump housing, direct the bottom of the notched sleeve flange toward the control rod setting groove of the pump housing.

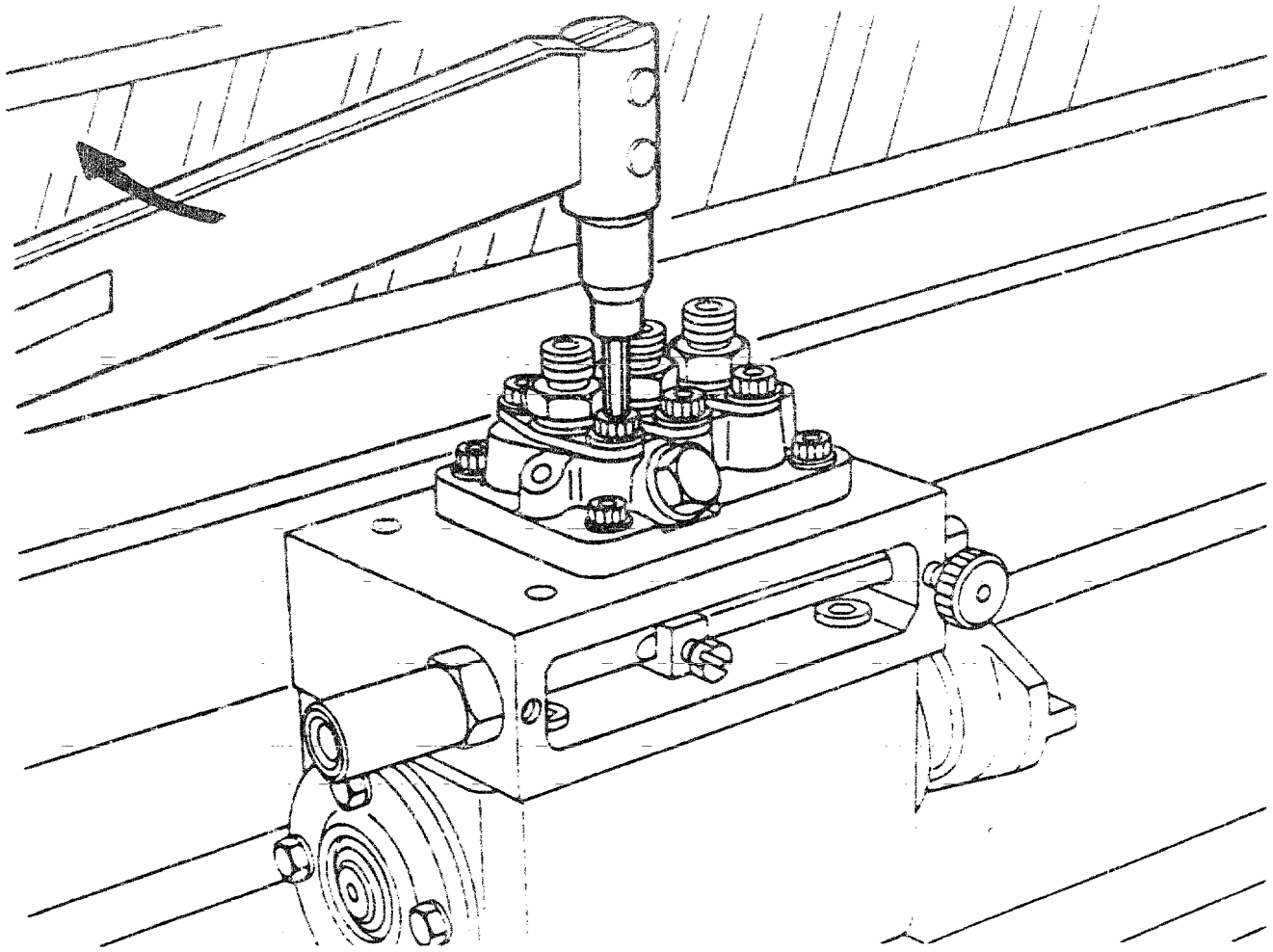

Fig. 66 Tightening socket head bolt

3. Tighten the socket head bolt to the specified torque.

   Specified tightening torque: 1 to 1.5 kg-m

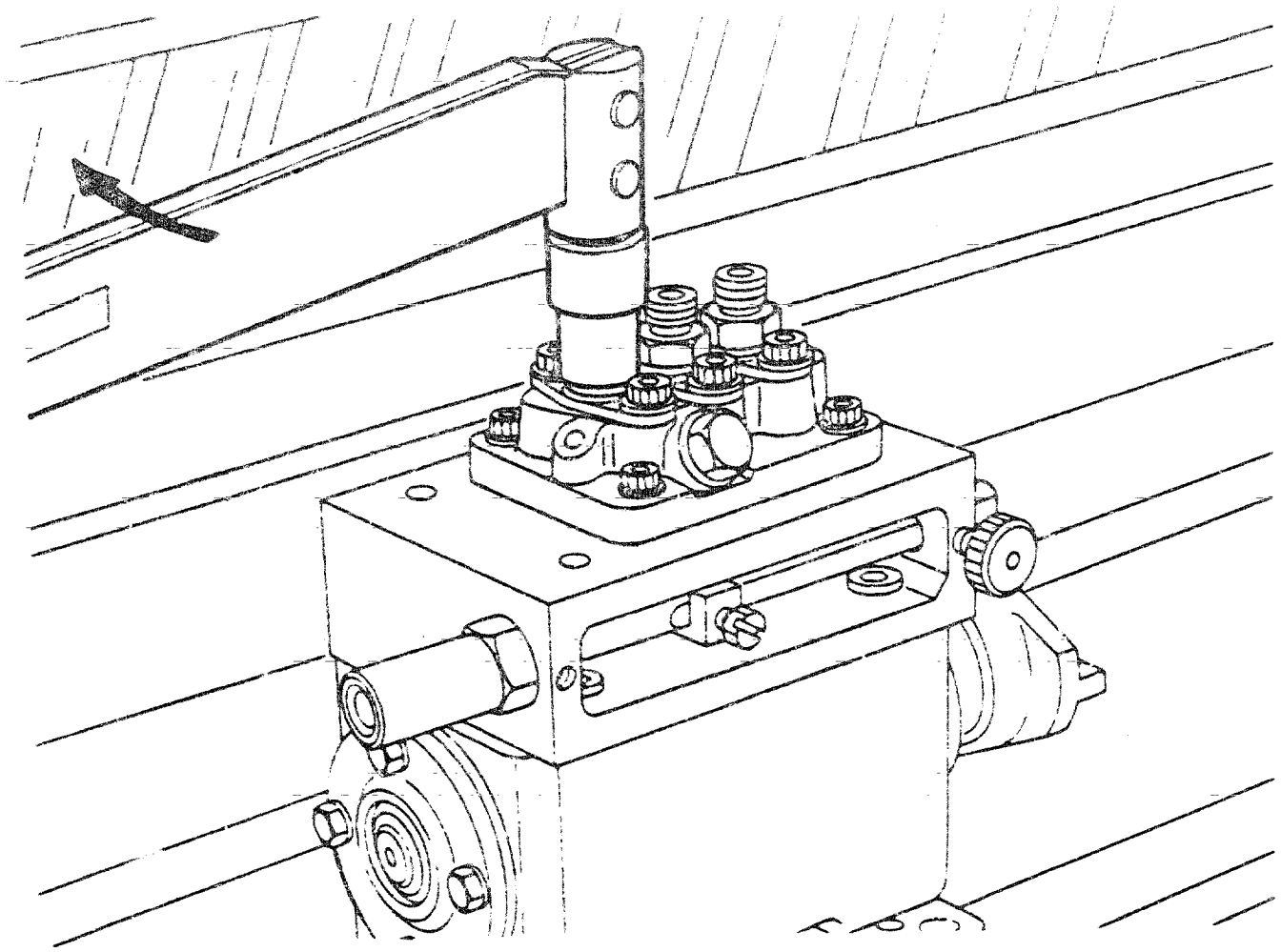

Fig. 67 Tightening delivery valve holder

4. Tighten the delivery valve holder to the specified torque.

   Specified tightening torque: 4 to 4.5 kg-m

5. Tighten the four screws (66) attaching the plate (65) to the pump housing after the threads have been coated with an adhesive.

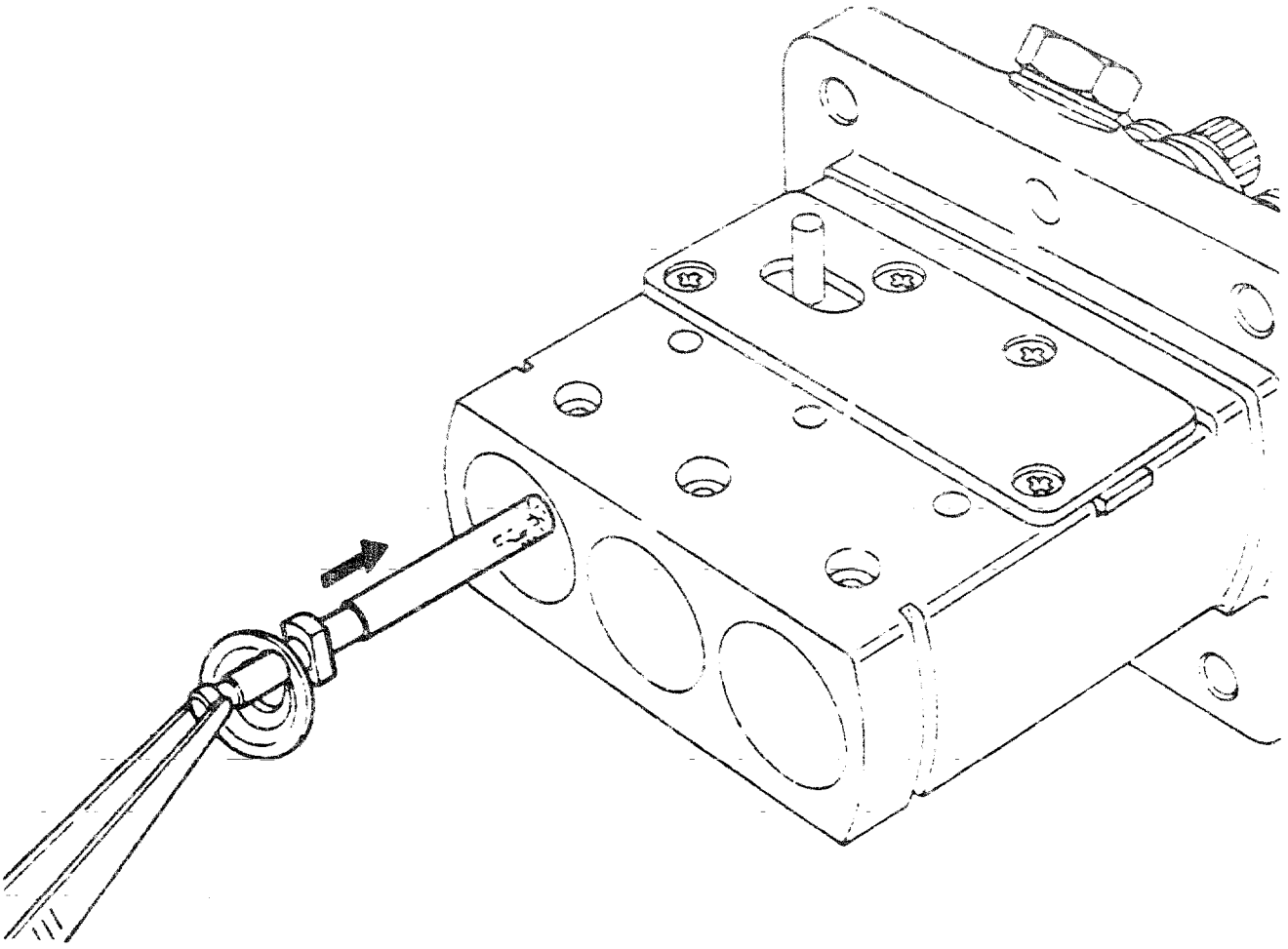

Fig. 68 Attaching plunger

6. When the plunger is attached to the plunger barrel, direct the plunger helix toward the opposite side of the control rod (plunger barrel positioning pin side).

Note: If the helix is set in the wrong position, the plunger flange cannot be inserted into the groove of the control sleeve.

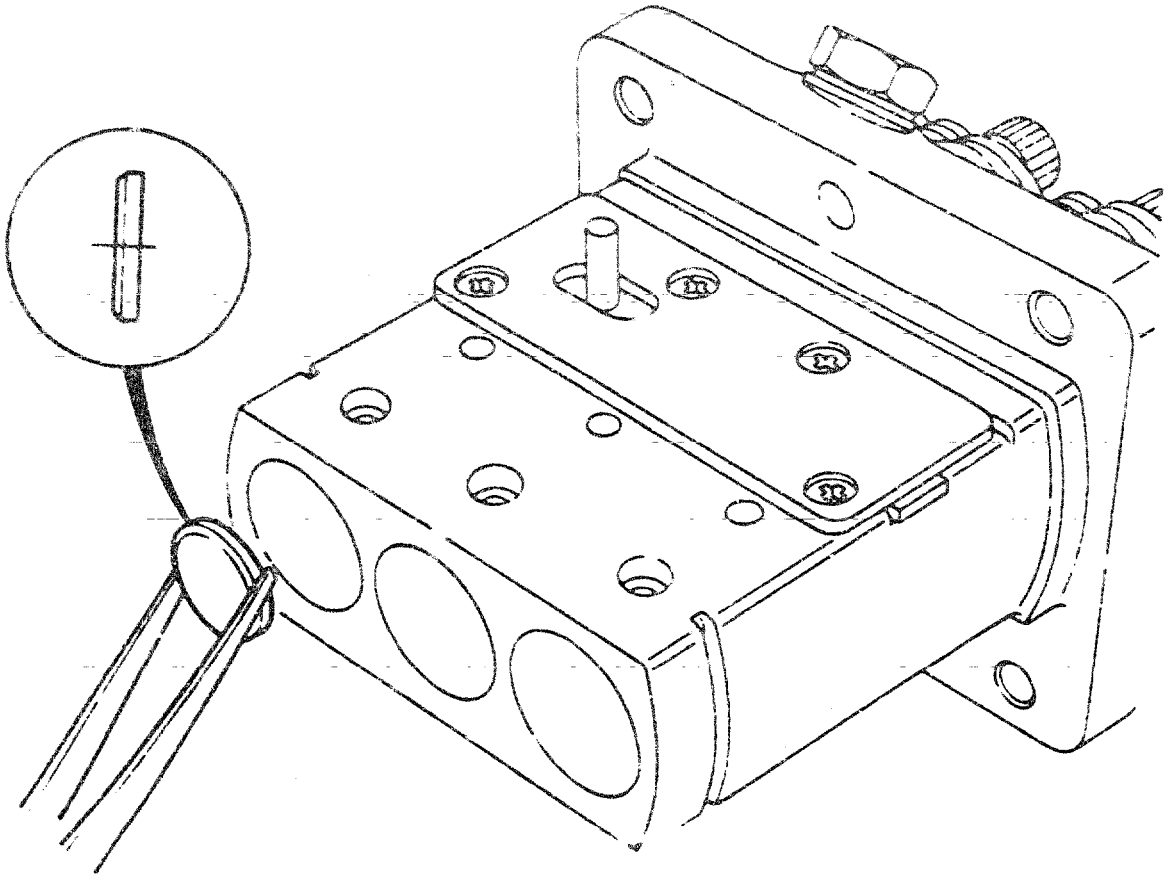

Fig. 69 Fitting the plate

7. Fit with the chamfered side of the plate facing the tappet side.

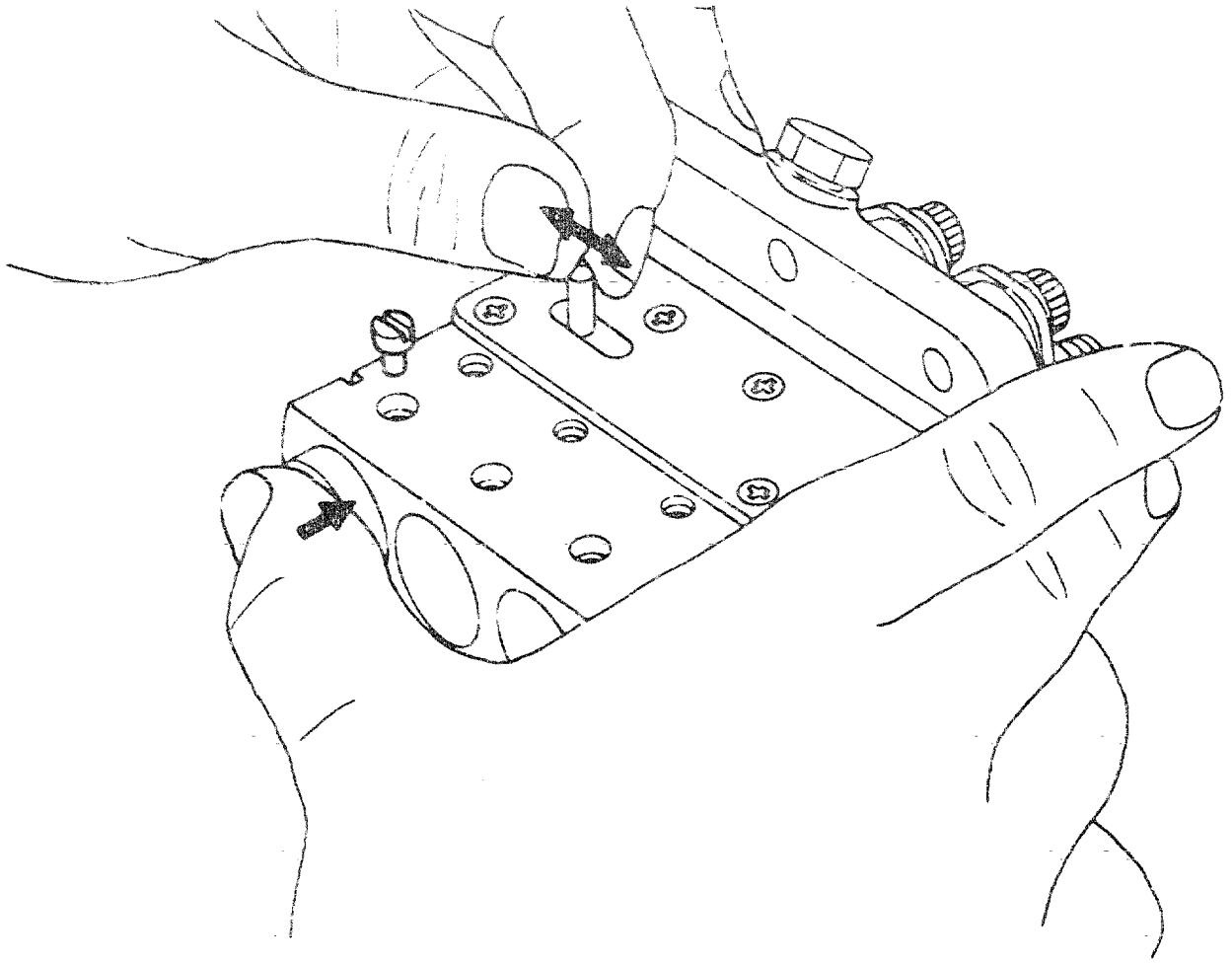

Fig. 70 Attaching tappet

8. When the pin (44) is inserted into the tappet, slowly move the control rod, pressing the tappet to find the position where the plunger flange fits the groove of the control sleeve.

9. After the pin grooves are set horizontally with a screwdriver, attach the snap ring.

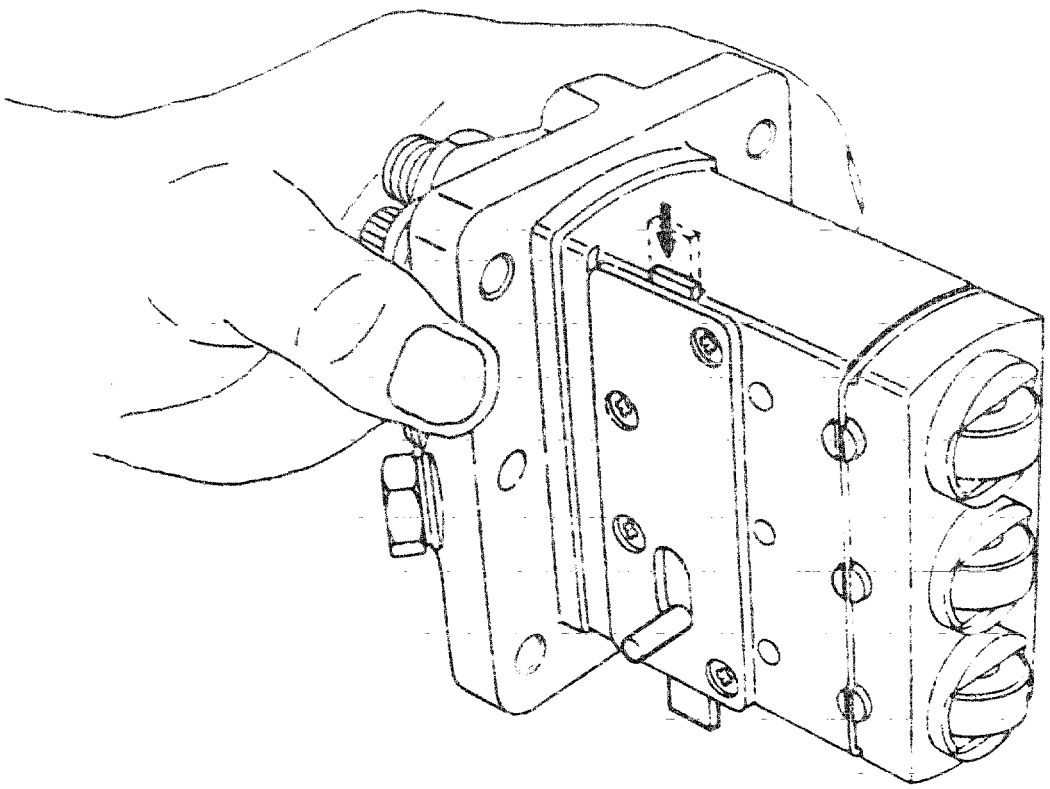

Fig. 71 Control rod movement inspection

10. After reassembly, check several times that the control rod moves smoothly under its own weight.

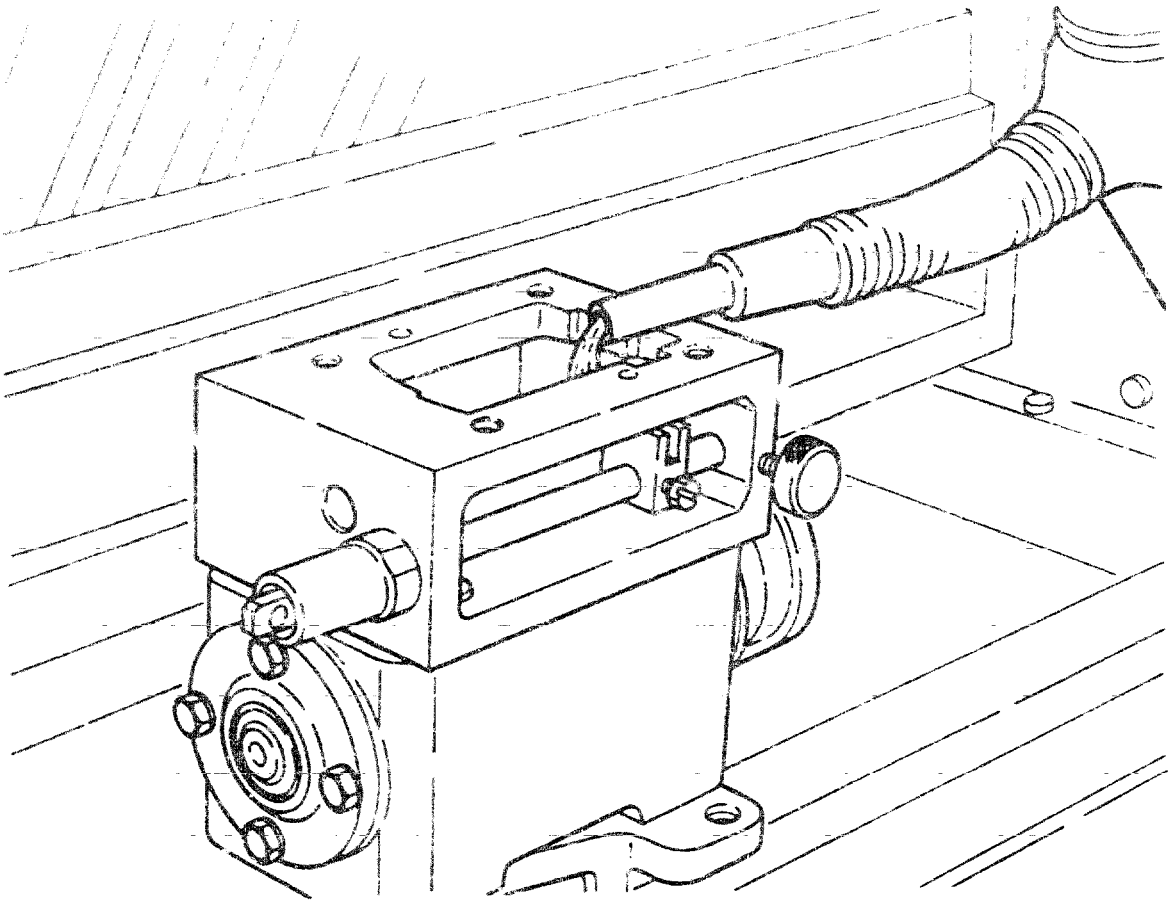

Fig. 72 Lubrication

ADJUSTMENT

PFR-KD Type Injection Pump

Preparations

PFR 3-KD pump adjustment is explained following.

1. Attach the driving stand (KDDC 0003) to the pump test stand, then fill the cam box with approximately 200 cc of lubricant.

Preparations (cont' d)

2. Attach the injection pump to the driving stand. Check that the control rack pin securely fits the control rod guide groove of the driving stand.

3. Fix the driving stand control rod and guide.

4. Rotate the cam shaft of the driving stand manually one or two turns.
   Check that it turns smoothly.

5. Securely connect the driving stand coupling to the pump test stand coupling.

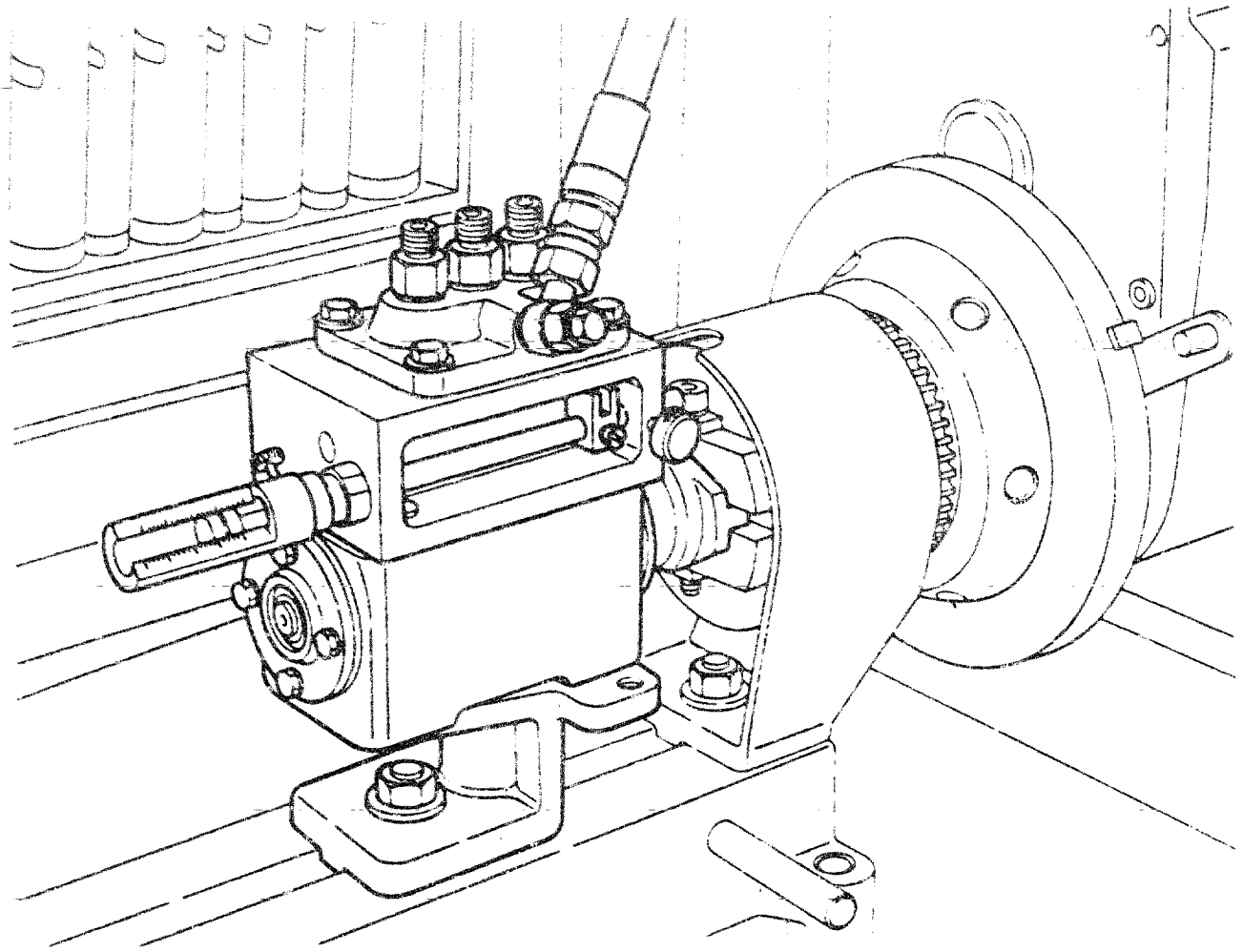

Fig. 73 Attaching measuring device and fuel oil pipe

6. Attach the measuring device (KDDC 0012) to the driving stand, and the test fuel oil supply pipe to the injection pump.

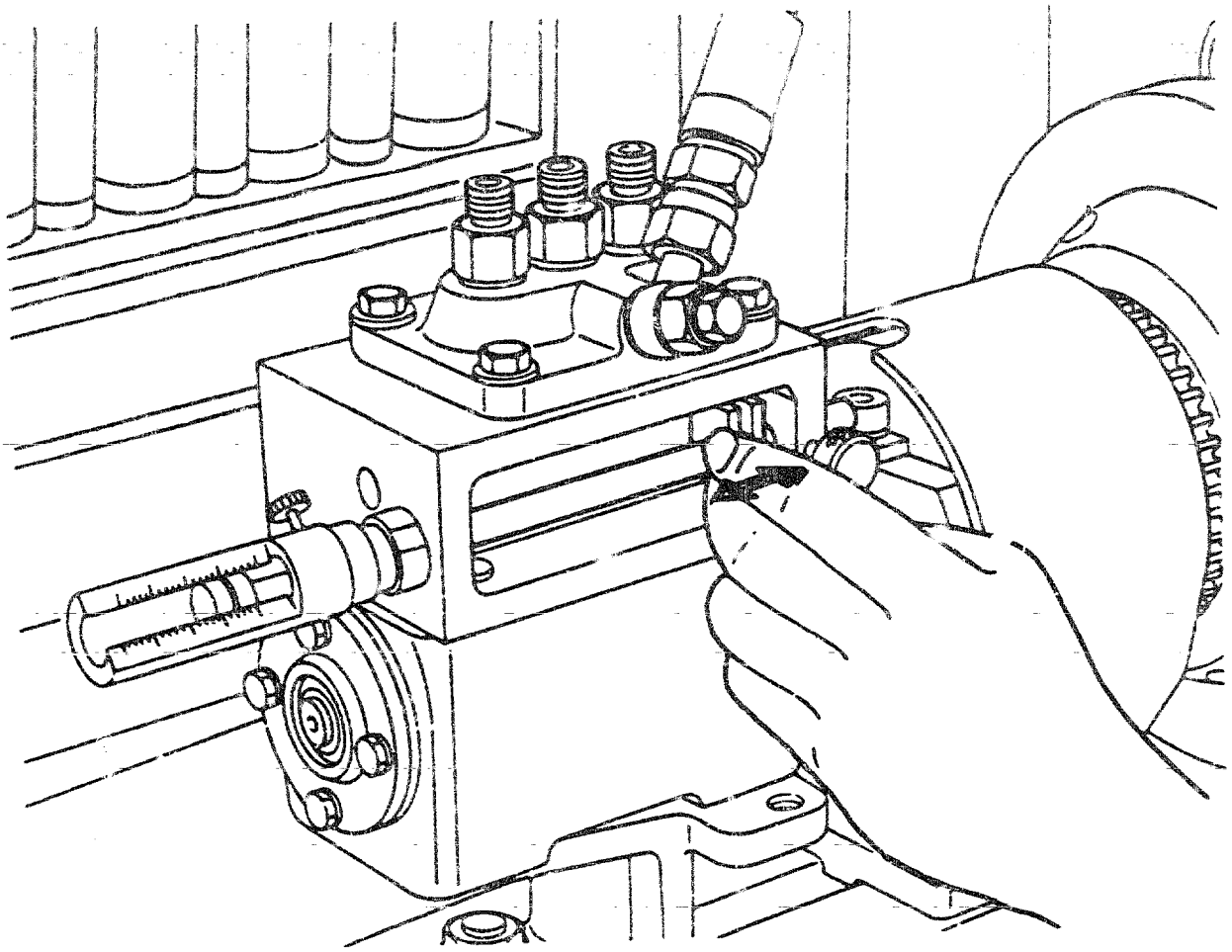

Fig. 74 Control rack "zero" point setting

7. With the control rack pressed fully to the "stop" direction, set the measuring device scale to "zero".

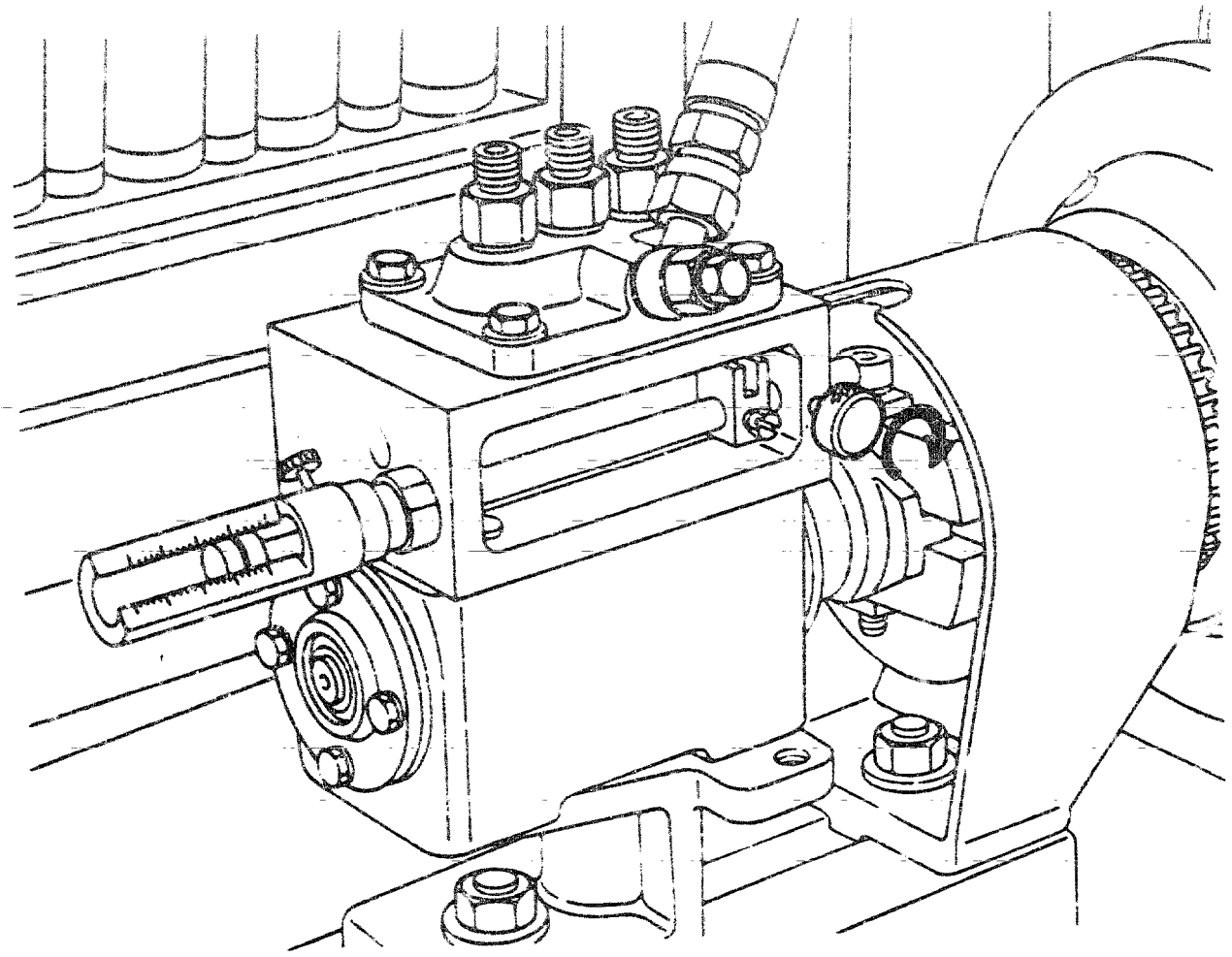

Fig. 75 Fixing control rack

Injection Timing Adjustment

1. Fix the control rack in the position specified as BASIC in the remarks column of the service data.

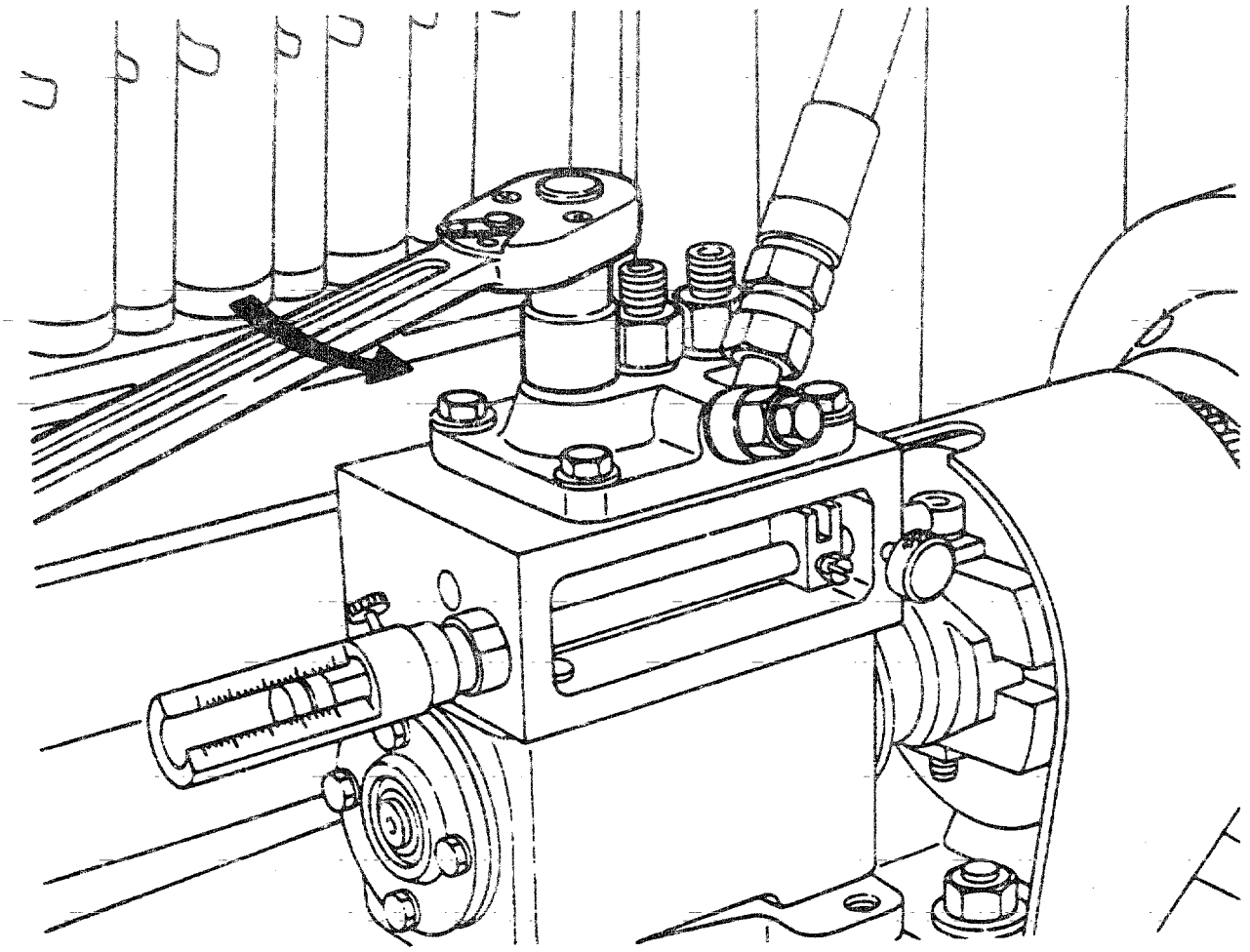

Fig. 76 Removing delivery valve holder

2. Remove the delivery valve holder.

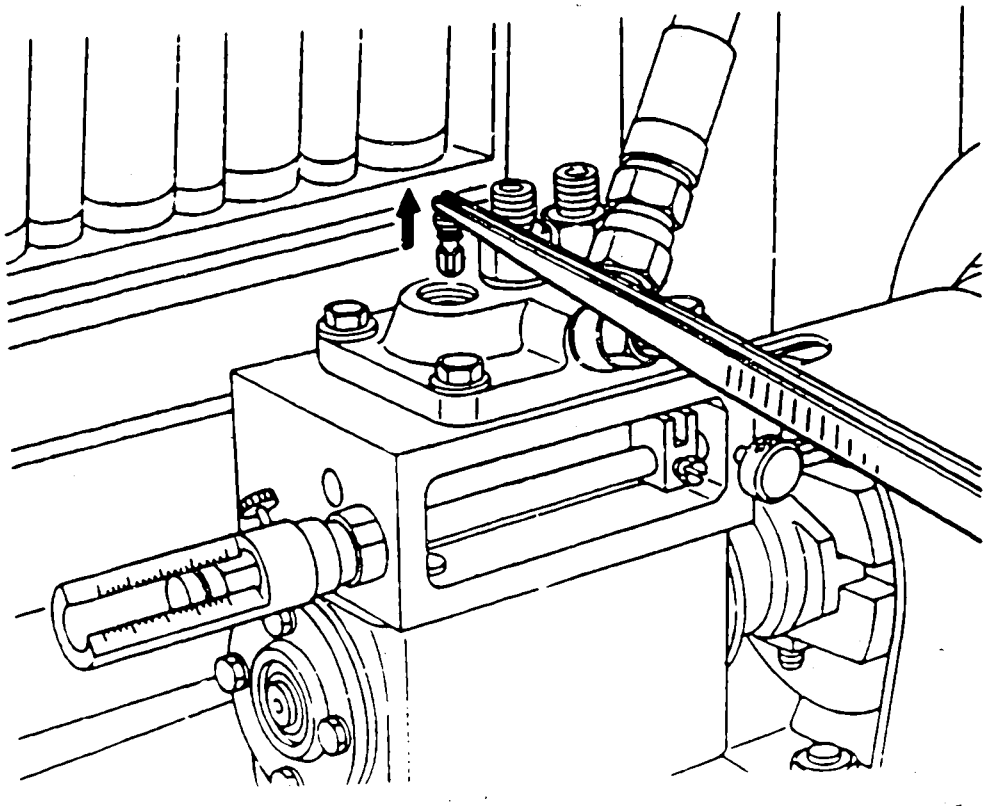

Bild 77 Druckventil herausnehmen

3. Druckventilfeder und Druckventil herausnehmen.

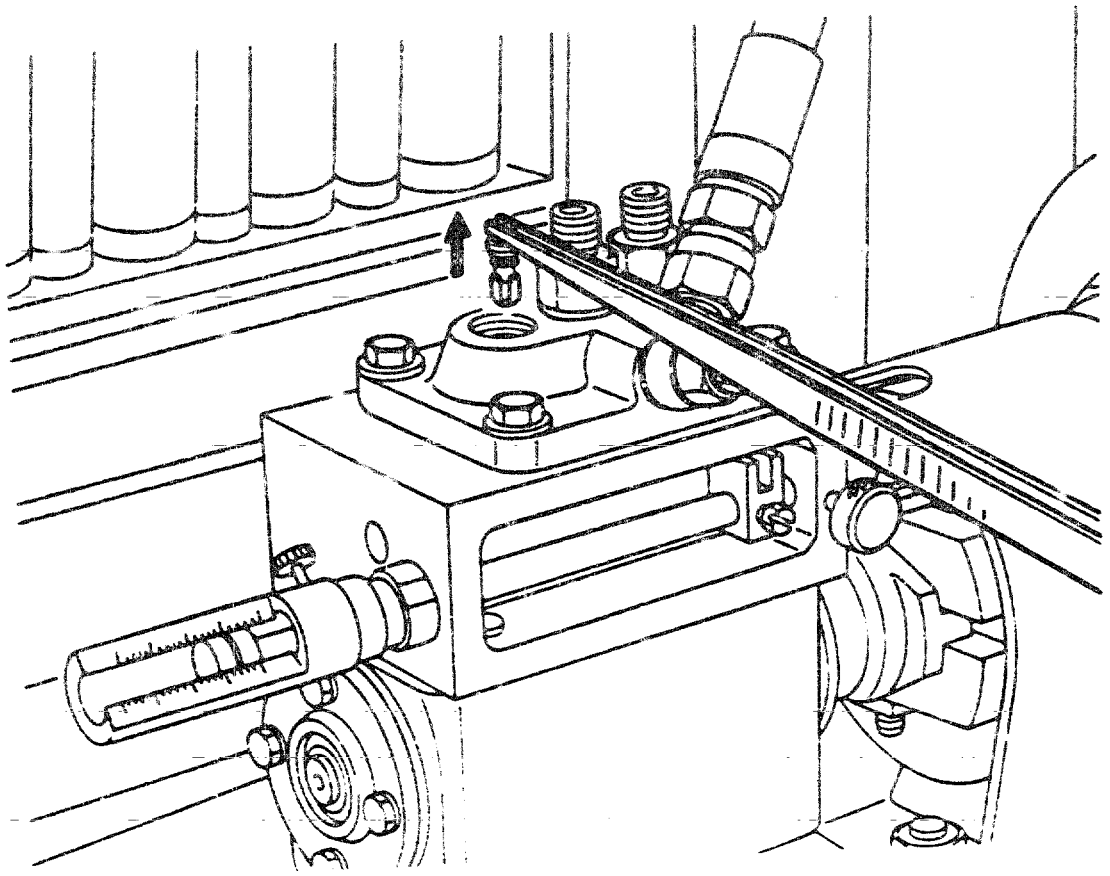

Fig. 77 Removing delivery valve

3. Remove the delivery valve spring and delivery valve.

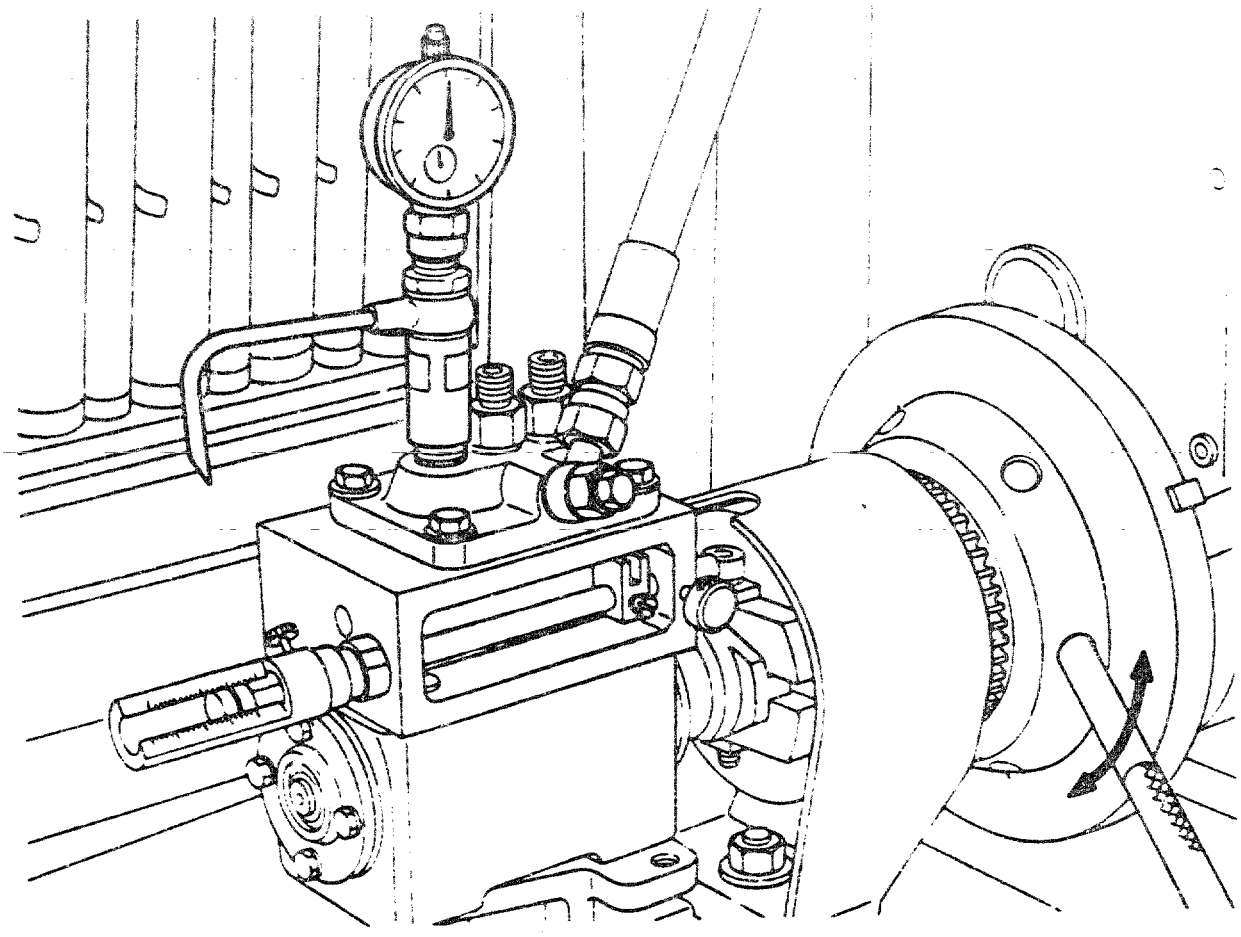

Fig. 78 Setting of "zero" point

4. After the measuring device **(KDDC 0010)** is attached to the injection pump, operate the pump test stand manually. Turn the driving stand cam shaft to set the cam of the cylinder to be measured at its bottom dead centre point. Then, set the dial gauge indicator to the zero point of the scale.

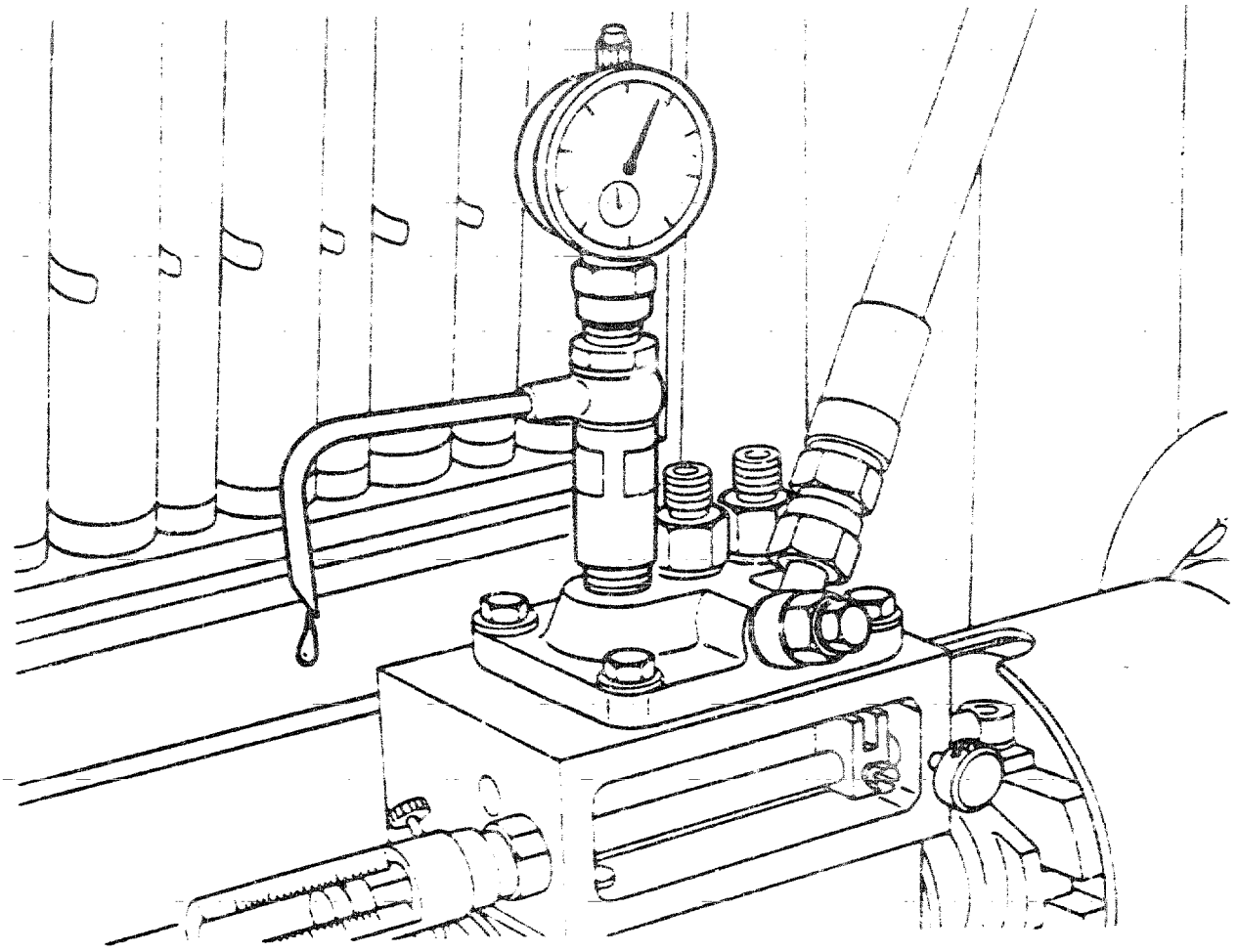

Fig. 79 Measuring plunger pre-stroke

5. Reduce the test fuel oil pressure as much as possible (e.g. 0.2 kg/cm^2), then feed fuel oil to the injection pump. At this time, the test fuel oil will flow out of the measuring device pipe, so the fuel oil must be caught in an oil pan.

6. Turn the cam shaft slowly by hand in a clockwise direction, viewed from the drive side. Read the value indicated by the dial gauge indicator when the test oil stops flowing out. If the value is not within the standard shown in the service data, adjust by changing the plate (53) thickness.

7. As above, attach the measuring device to each of the other cylinders, and measure the plunger pre-stroke.

8. After the measuring device is removed, attach the delivery valve, delivery valve spring and delivery valve holder. Tighten the delivery valve holder to the specified tightening torque.

Plate Data

Part Number *	Thickness (mm)	Stamping	Part Number *	Thickness (mm)	Stamping
140217-5000	2,60	260	140217-6600	3,40	340
-5100	2,65	265	-6700	3,45	345
-5200	2,70	270	-6800	3,50	350
-5300	2,75	275	-6900	3,55	355
-5400	2,80	280	-7000	3,60	360
-5500	2,85	285	-7100	3,65	365
-5600	2,90	290	-7200	3,70	370
-5700	2,95	295	-7300	3,75	375
-5800	3,00	300	-7400	3,80	380
-5900	3,05	305	-7500	3,85	385
-6000	3,10	310	-7600	3,90	390
-6100	3,15	315	-7700	3,95	395
-6200	3,20	320	-7800	4,00	400
-6300	3,25	325	-7900	4,05	405
-6400	3,30	330	-8000	4,10	410
-6500	3,35	335			

* Bosch Nr., see cross reference DKKC - Bosch, microfiche HB 30, HB 31.

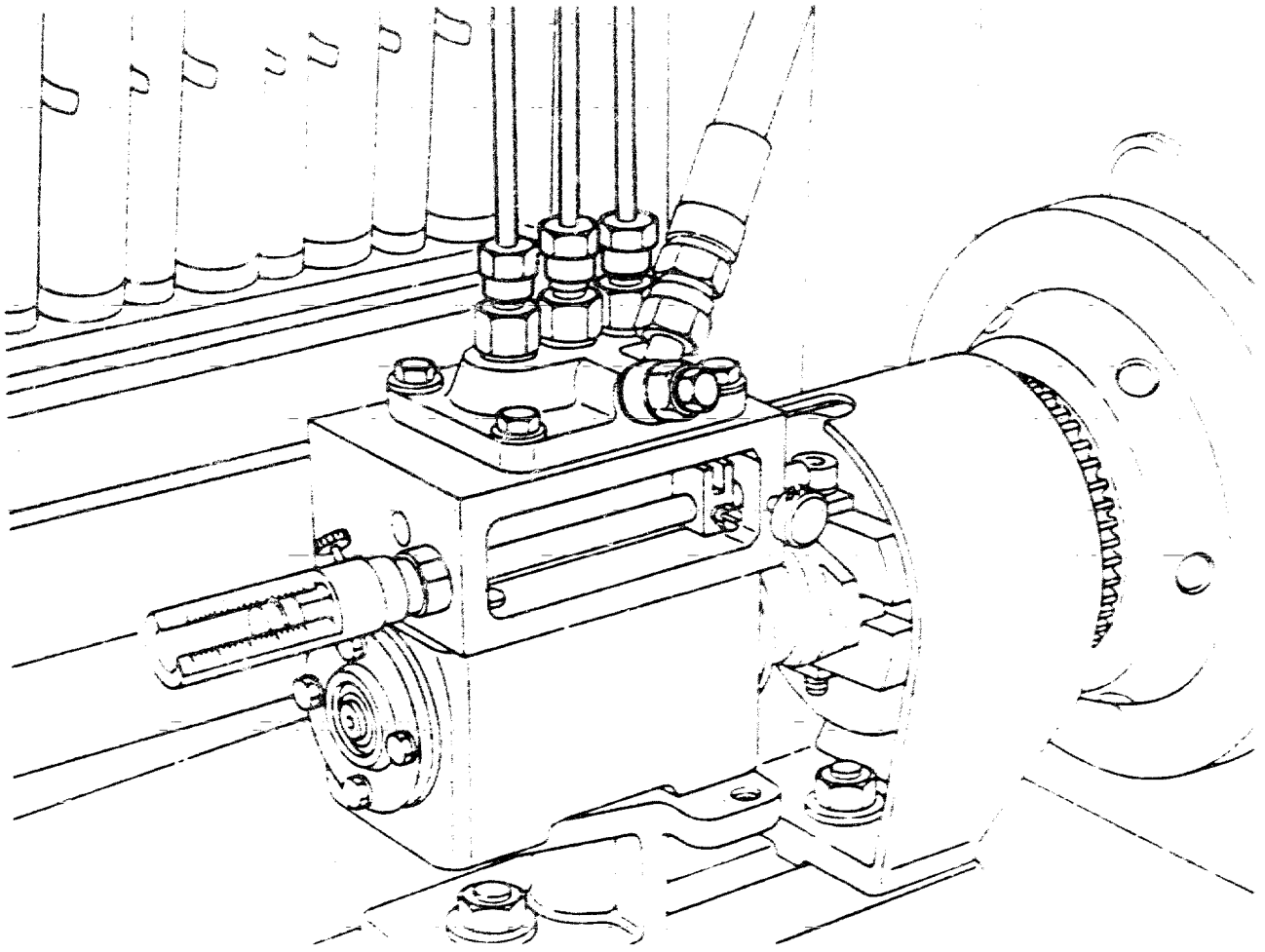

Fig. 80 Attaching injection pipe

Injection Quantity Adjustment

1. Attach the test nozzle holder (KDDC 0009) to the pump test stand and connect the injection pipe (1 680 750 014) to the delivery valve holder.
2. Fix the control rack in the position specified in the service data.
3. Measure the injection quantities during the conditions specified in the service data.

Note: The direction of rotation of the driving stand cam shaft is clockwise when viewed from the drive side.

4. If the injection quantity of the standard cylinder deviates from the standard value, change the control rack position slightly, then remeasure. Repeat this operation until the injection quantity of the standard cylinder matches the standard value

Note: The standard cylinder refers to a cylinder whose pump housing is press-fitted with the plunger barrel positioning pin. (The center cylinder in a 3-cylinder injection pump)

BETRIEBSVORSCHRIFTEN

Handhabung

Die Einspritzpumpe ist ein Präzisionsgerät und spielt eine wichtige Rolle als Herz des Motors, deshalb soll sie nicht unnötig auseinandergebaut werden.

Sollte im Betriebsverhalten des Motors eine Verschlechterung eintreten oder der Motor nicht angelassen werden können, so ist im Werkstatthandbuch des betreffenden Motors nachzusehen. Einspritzpumpe erst dann ausbauen und zerlegen, wenn die Betriebsstörung eindeutig auf die Pumpe zurückzuführen ist.

Plombierung

Die Fördermengeneinstellpunkte sind mit Bleiplomben versehen.

Zerlegung und Einstellung der Einspritzpumpe nicht ohne Pumpenprüfstand durchführen.

Einspritzpumpe ausbauen

Die Einspritzpumpe ist nach den Angaben im Werkstatthandbuch für den betreffenden Motor auszubauen. Dabei ist der Verstellhebel des Drehzahlreglers in der angegebenen Stellung zu fixieren und danach die Gestängeverbindung zwischen der Regelstange der Einspritzpumpe und dem Drehzahlregler zu lösen.

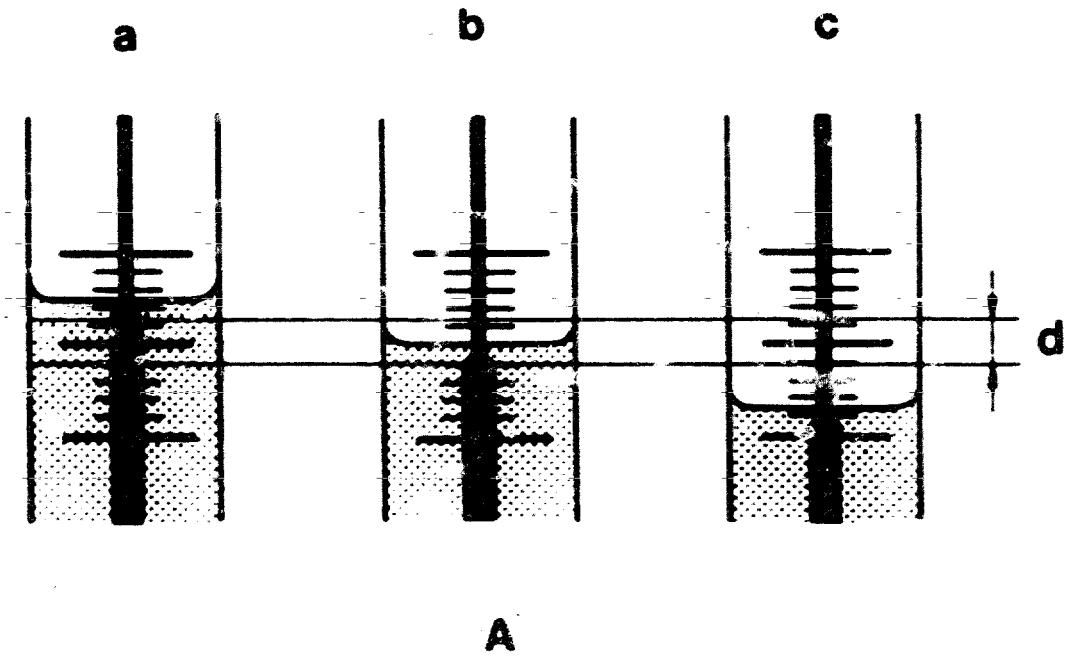

Fig. 81 Measuring fuel injection quantity

A = Standard cylinder

a = poor
b = good
c = poor
d = specified limits

5 When the injection quantity of each cylinder, other than the standard cylinder, deviates from the standard value, adjustment must be performed as described below.

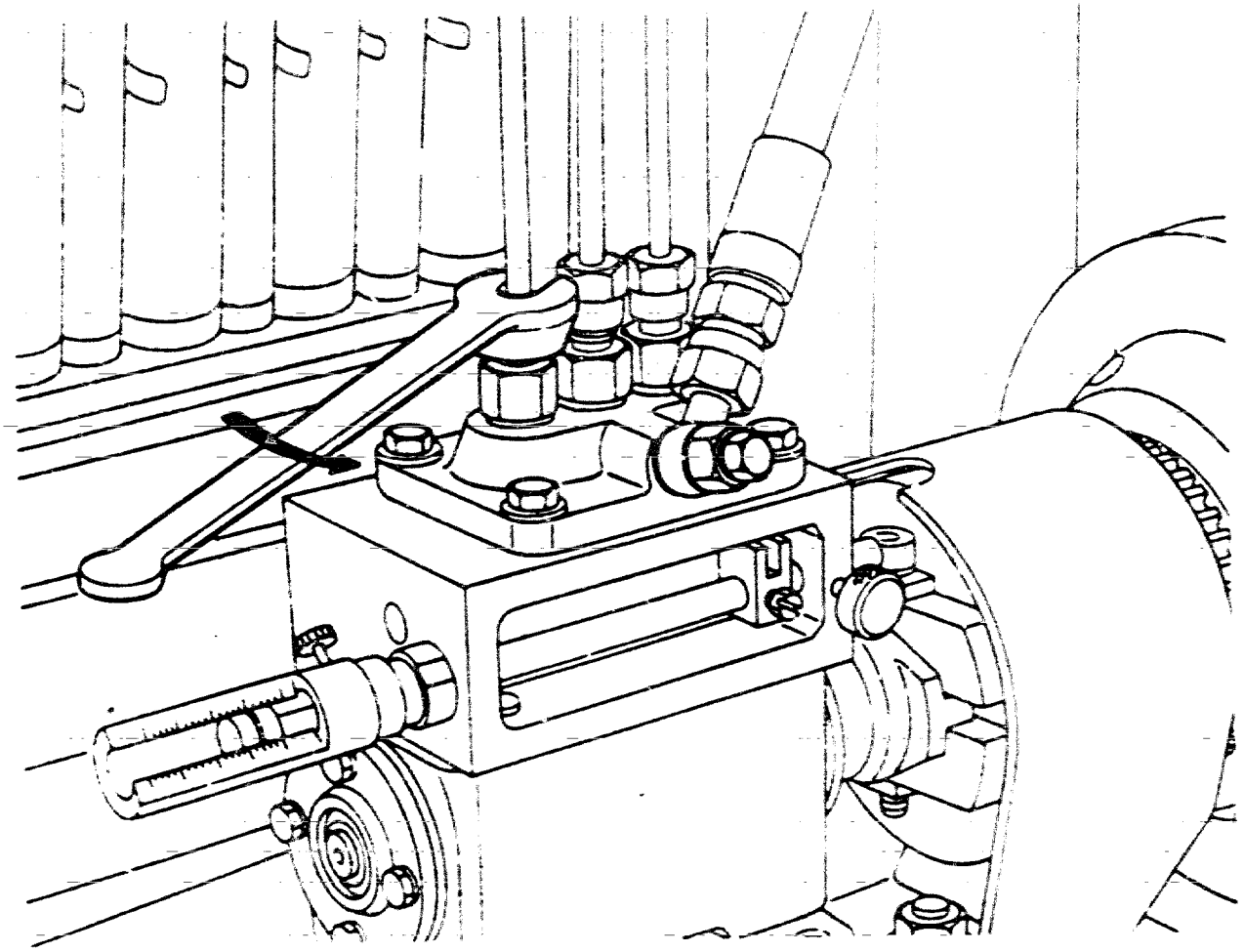

Fig. 82 Removing injection pipe

1) Remove the injection pipe of the cylinder to be adjusted.

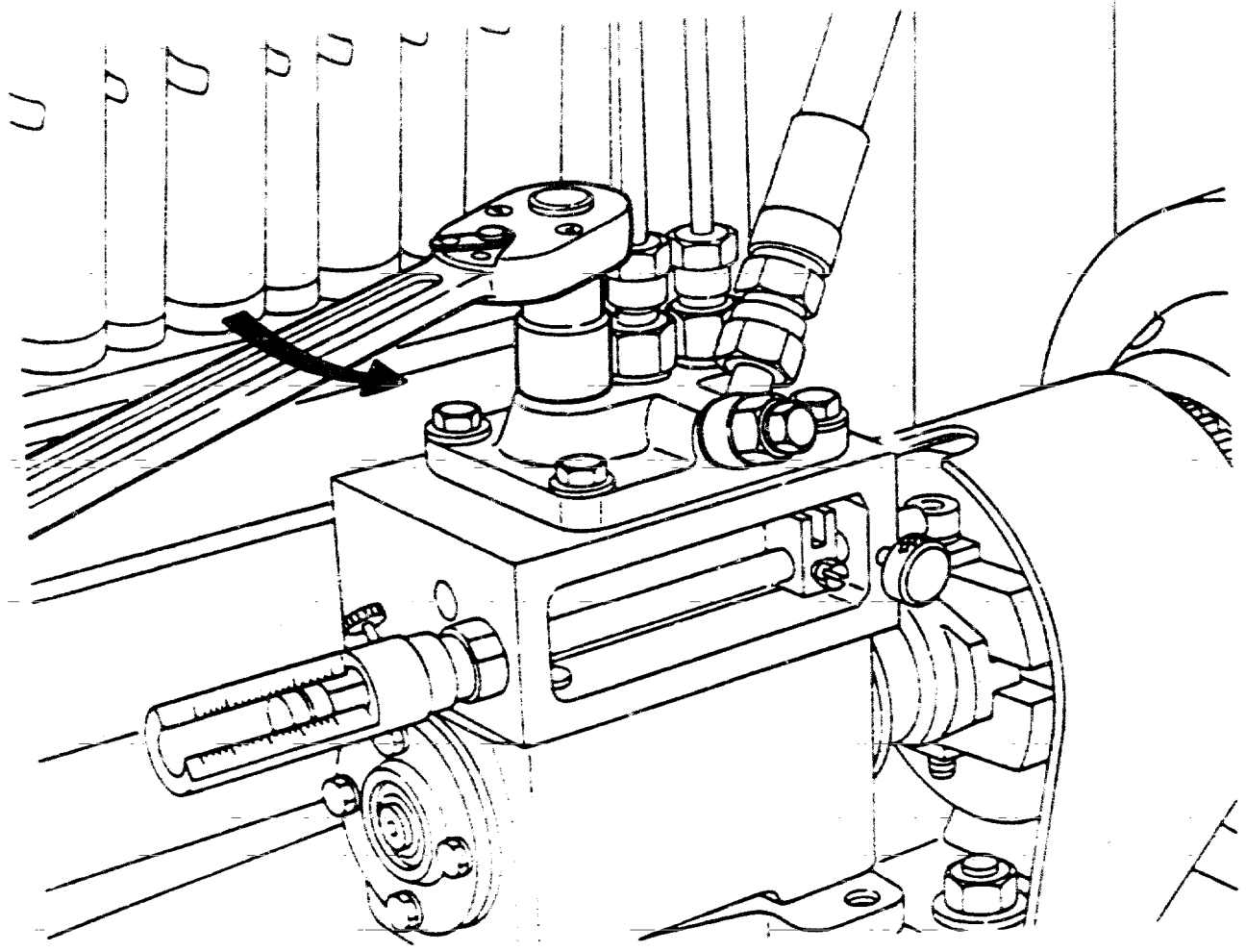

Fig. 83 Loosening delivery valve holder

2) Because the plunger barrel must be turned with the eccentric pin, loosen the delivery valve holder.

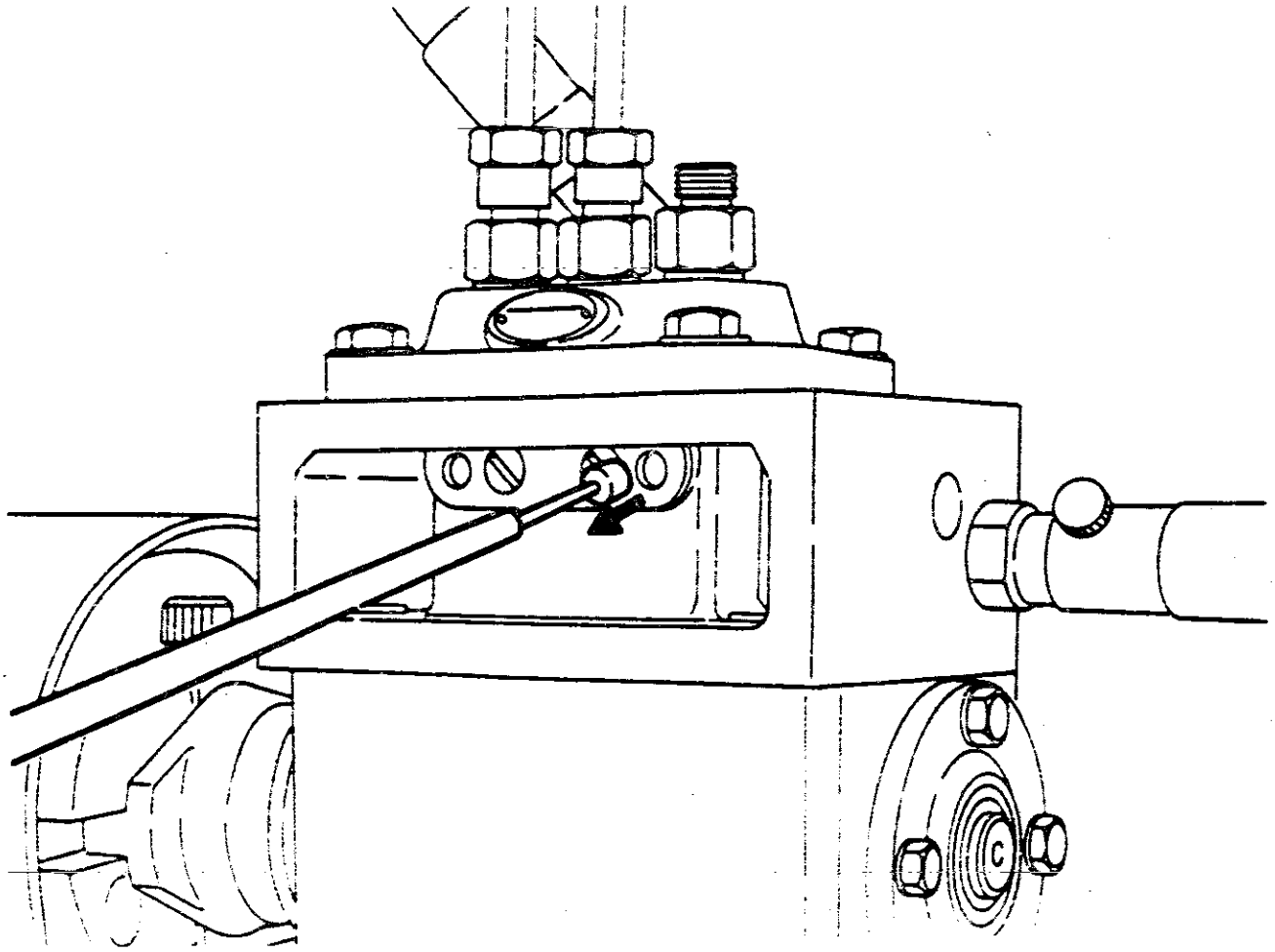

Fig. 84 Removing plug

3) Remove the sealing plug (160).

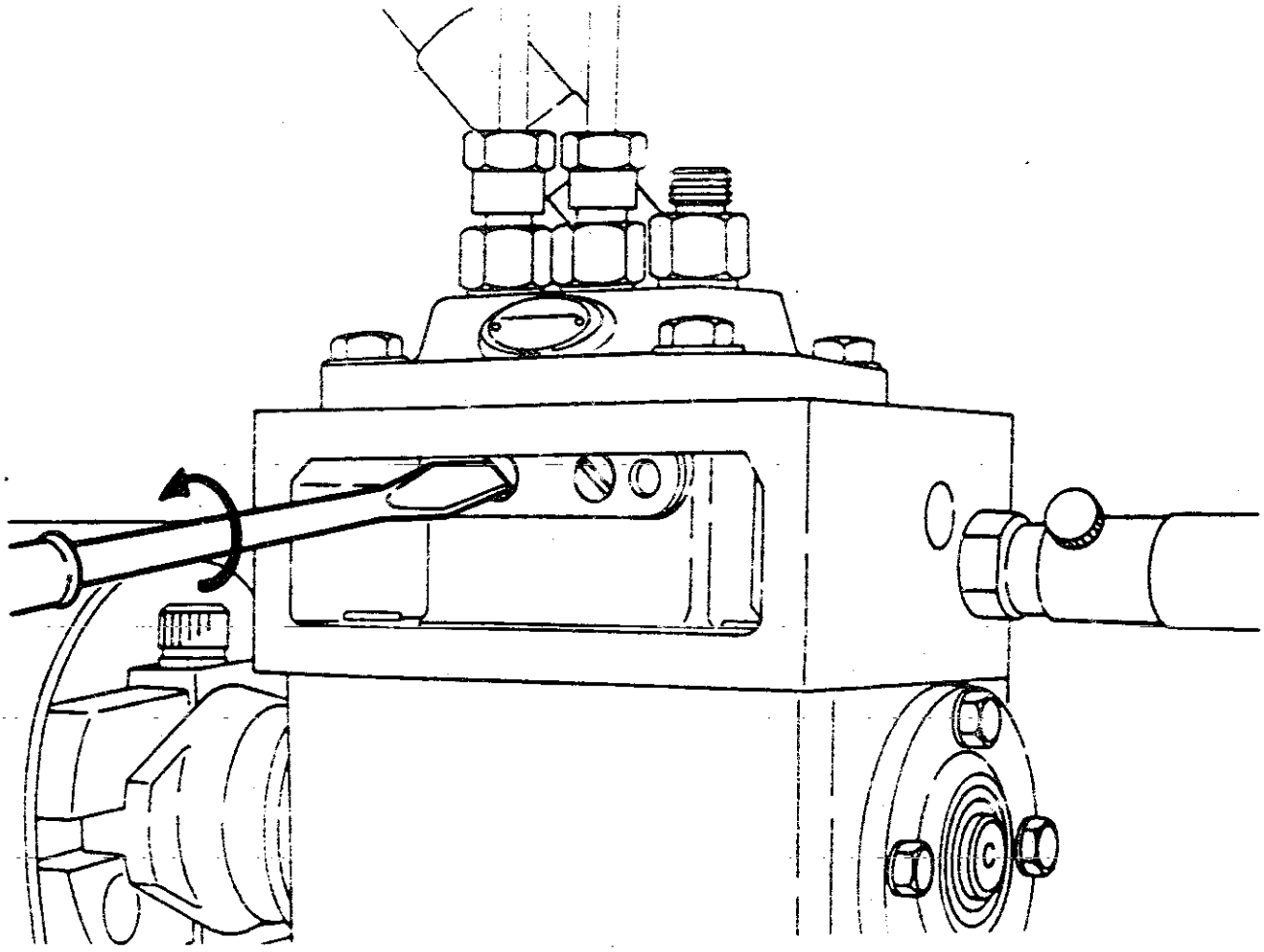

Fig. 85 Loosening screws

4) Loosen the two screws (159) by one turn.

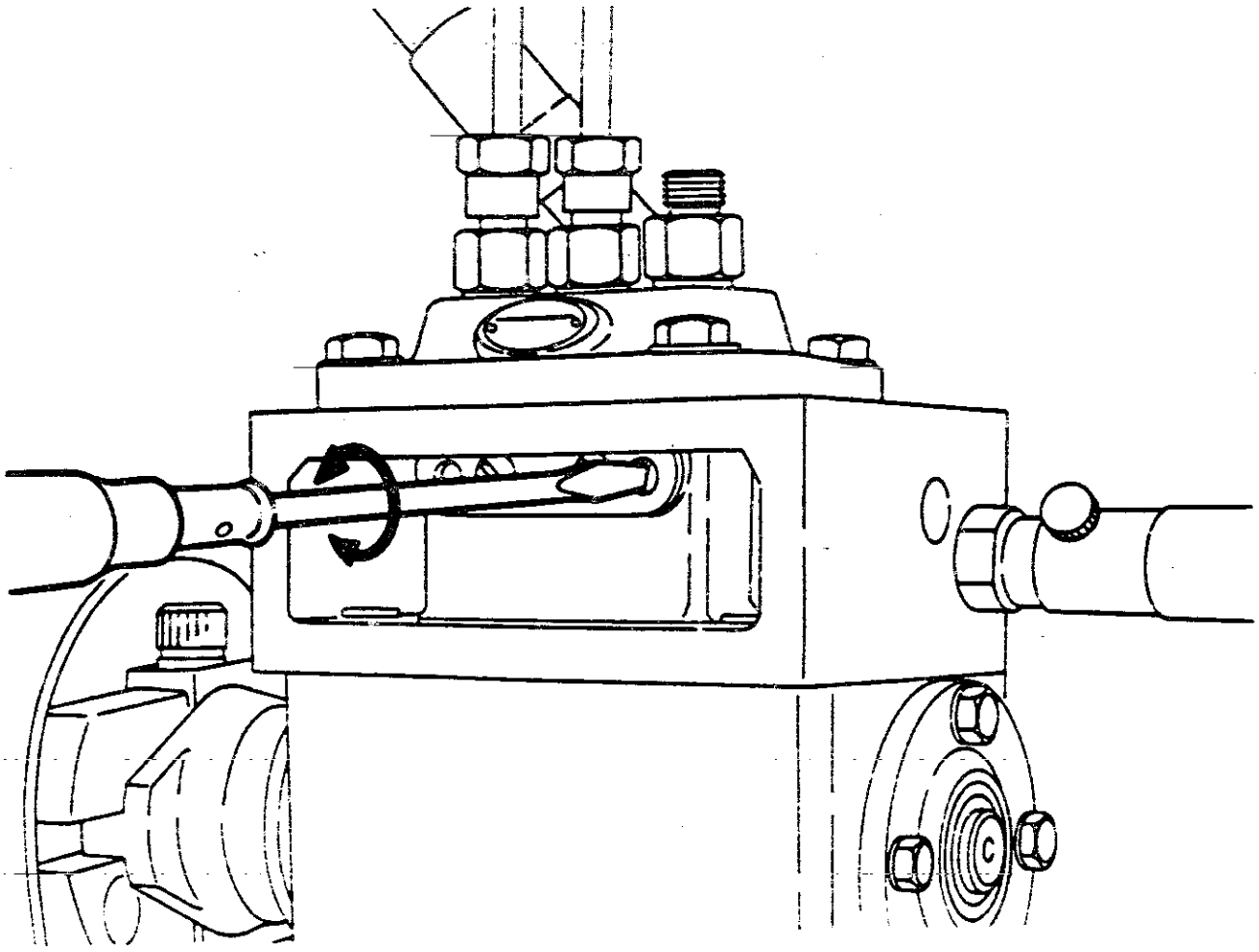

Fig. 86 Adjusting injection quantity

5) Slightly turn the eccentric pin (156) of the cylinder to be adjusted through the cover (158) hole. The plunger barrel will turn and the injection quantity will vary as described below

When the eccentric pin is turned clockwise,
Right helix plunger: The injection quantity decreases.
Left helix plunger: The injection quantity increases.

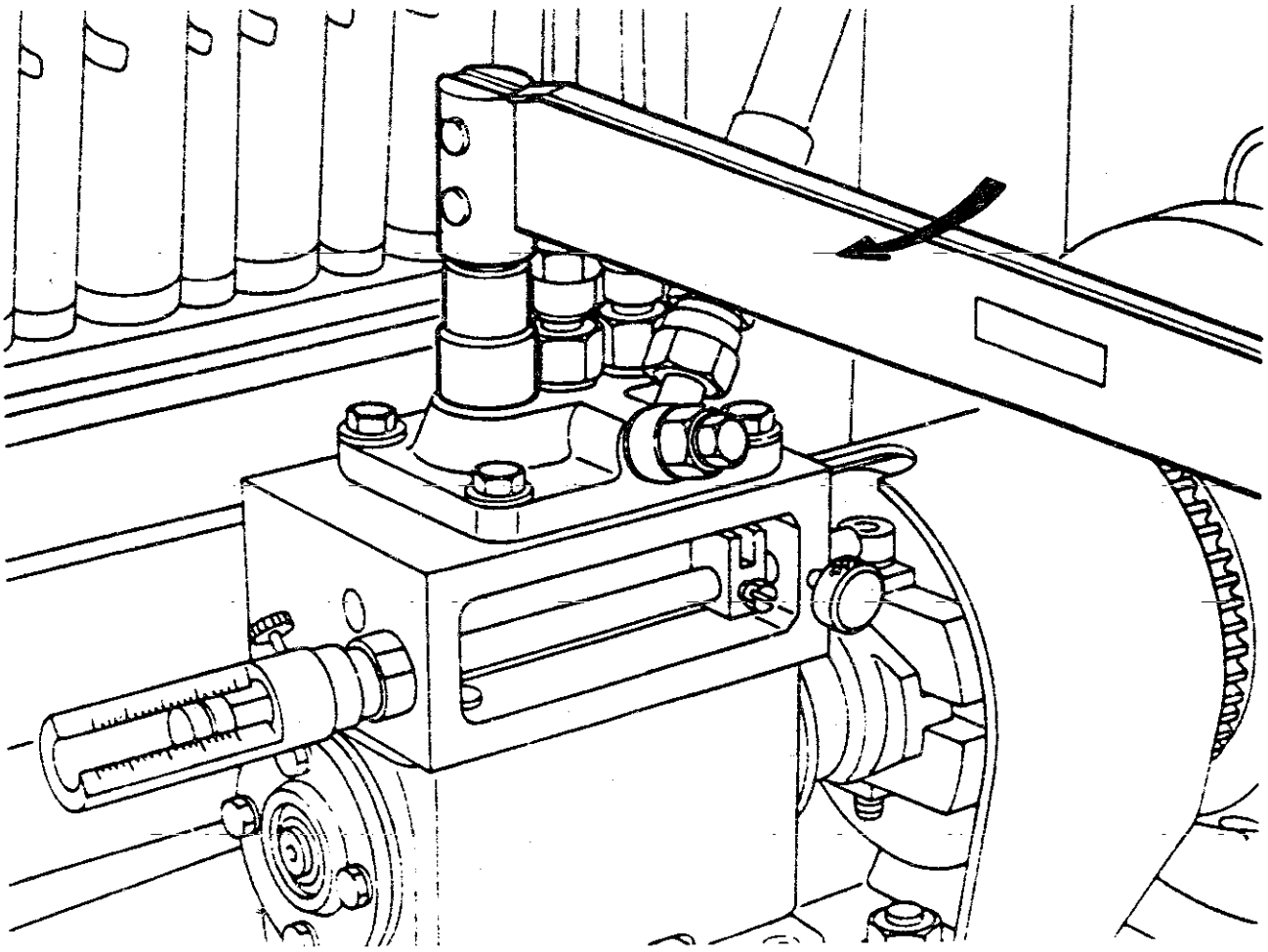

Fig. 87 Tightening delivery valve holder

6) Tighten the delivery valve holder to the specified torque and measure the injection quantity again after the injection pipe is attached.

Specified tightening torque:

4 to 4.5 kg-m

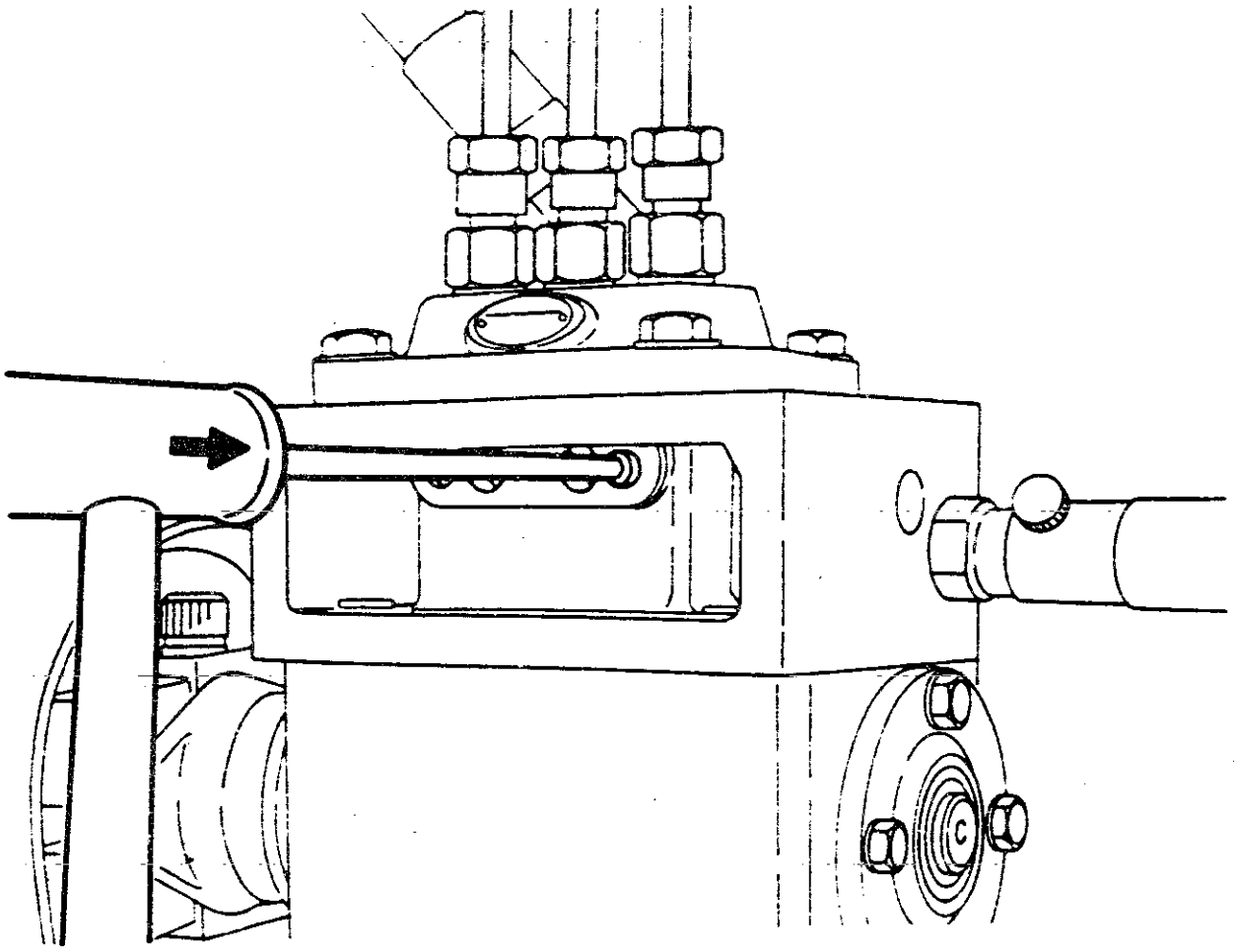

Fig. 88 Inserting plug

6. When the injection quantity of each cylinder matches the standard value, fix the cover (158) with two screws (159) and insert the sealing plugs (160) into the cover's adjustment holes.

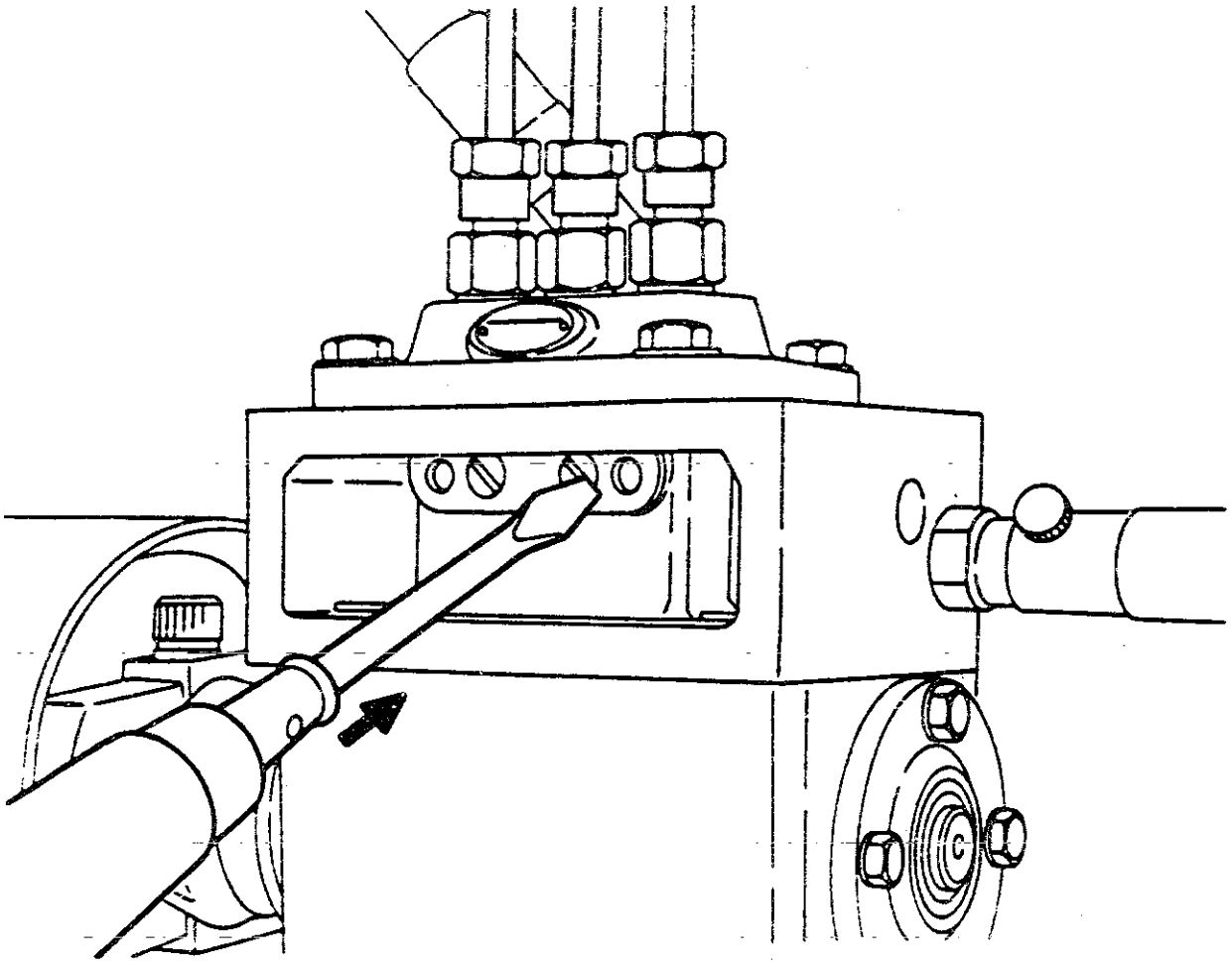

Fig. 89 Screw-stamping

Note: Later model pumps do not use plugs. To secure the screws, position a screw driver half into the screw groove and over lapping the cover, and tap sharply.

7. After adjustment is completed, check that each screw is tightened to the specified torque. (See Fig. 107.)

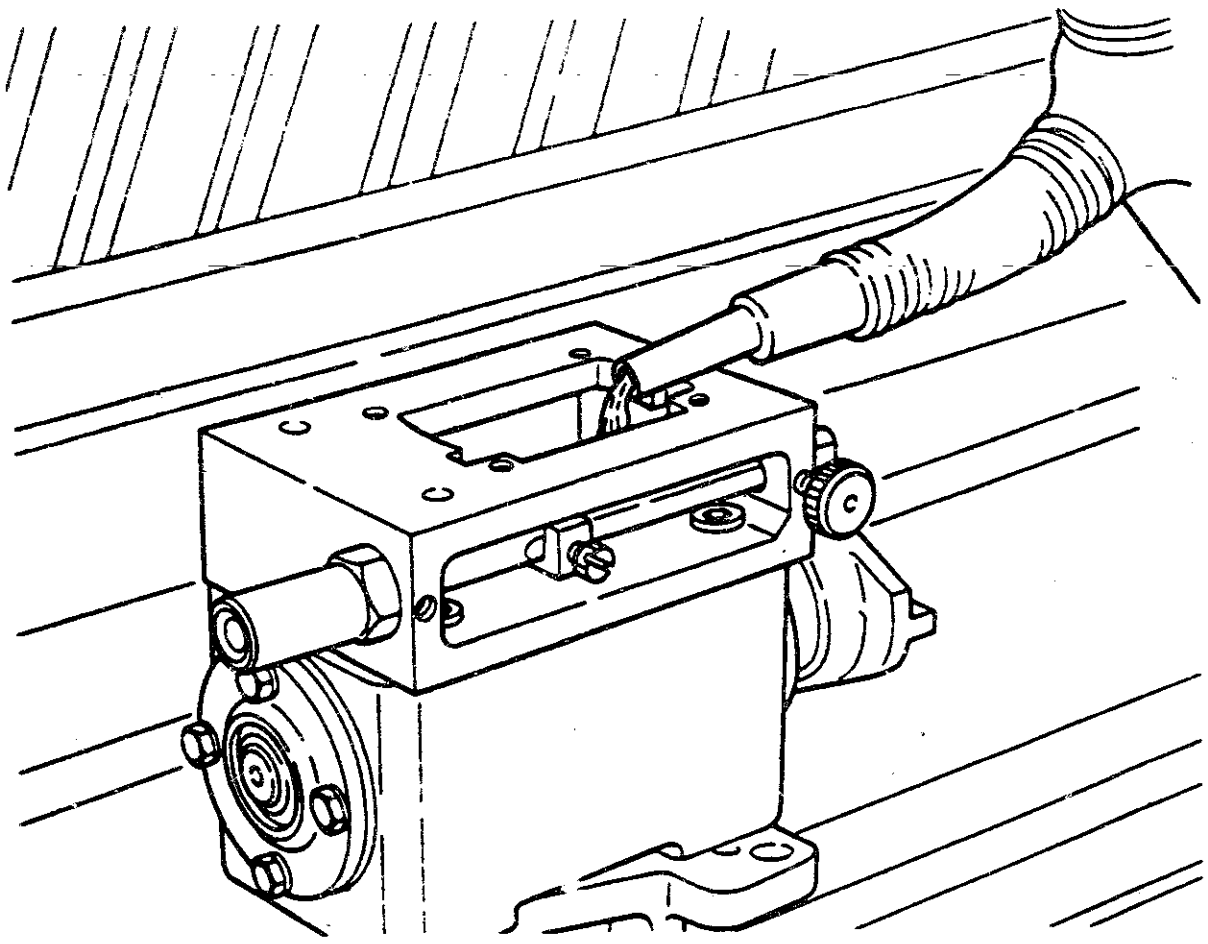

Fig. 90 Lubrication

PFR-MD Type Injection Pump

Preparations

PFR 3-MD pump is explained following.

1. Attach the driving stand (KDDC 0007) to the pump test stand, then fill the cam box with approximately 200 cc of lubricant.

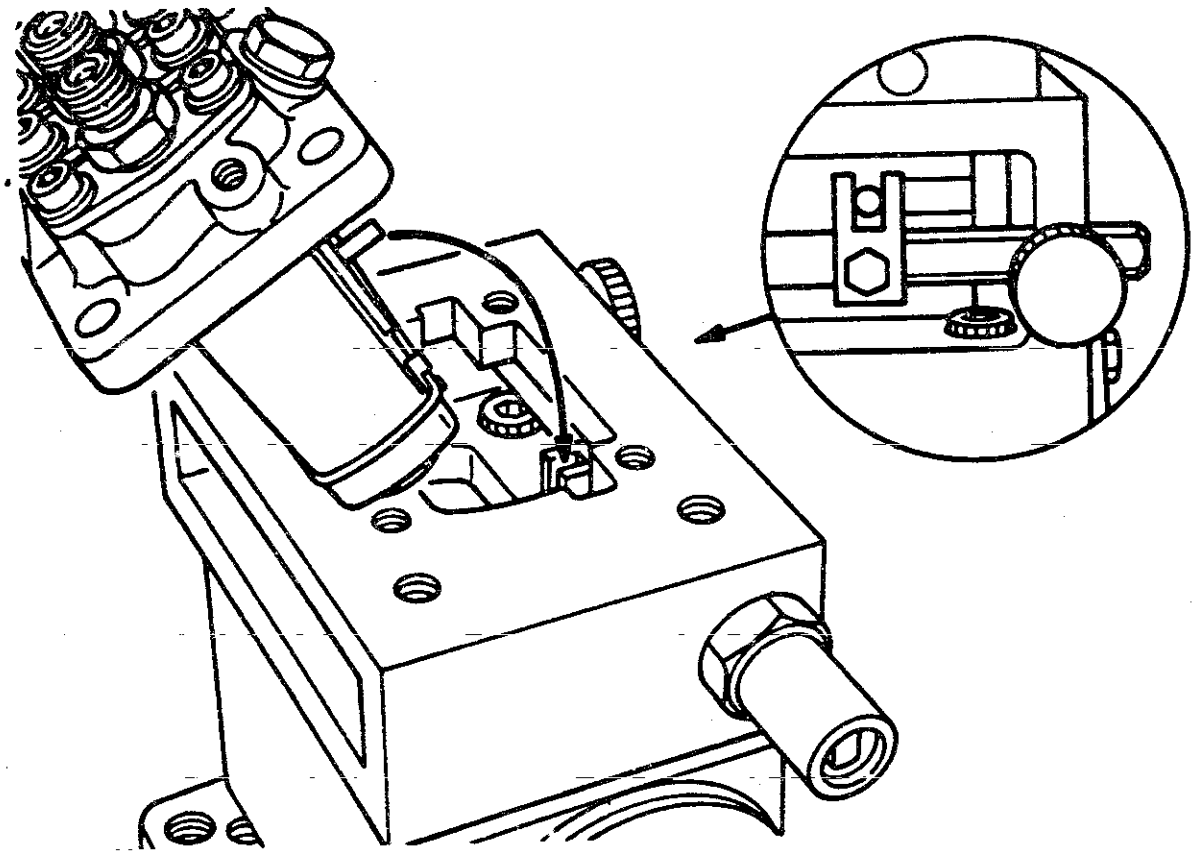

Fig. 91 Attaching injection pump

2. Attach the injection pump to the driving stand.

   Check that the control rack pin securely fits the control rod guide groove of the driving stand.

3. Rotate the cam shaft of the driving stand manually one or two turns. Check that it turns smoothly.

4. Securely connect the driving stand coupling to the pump test stand coupling.

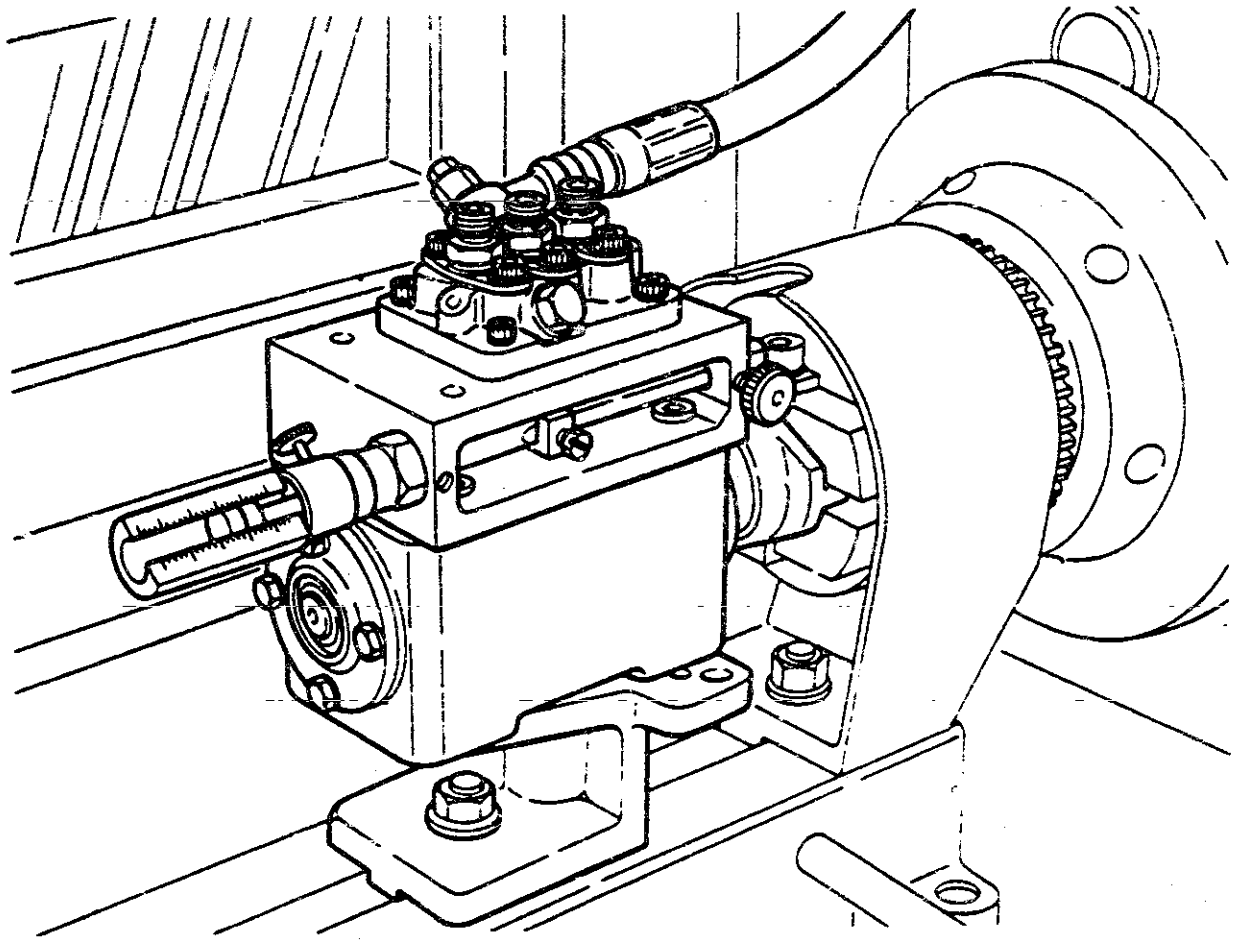

Fig. 92 Attaching measuring device and fuel pipe

5. Attach the measuring device (KDDC 0012) to the driving stand, and the test oil supply pipe to the injection pump.

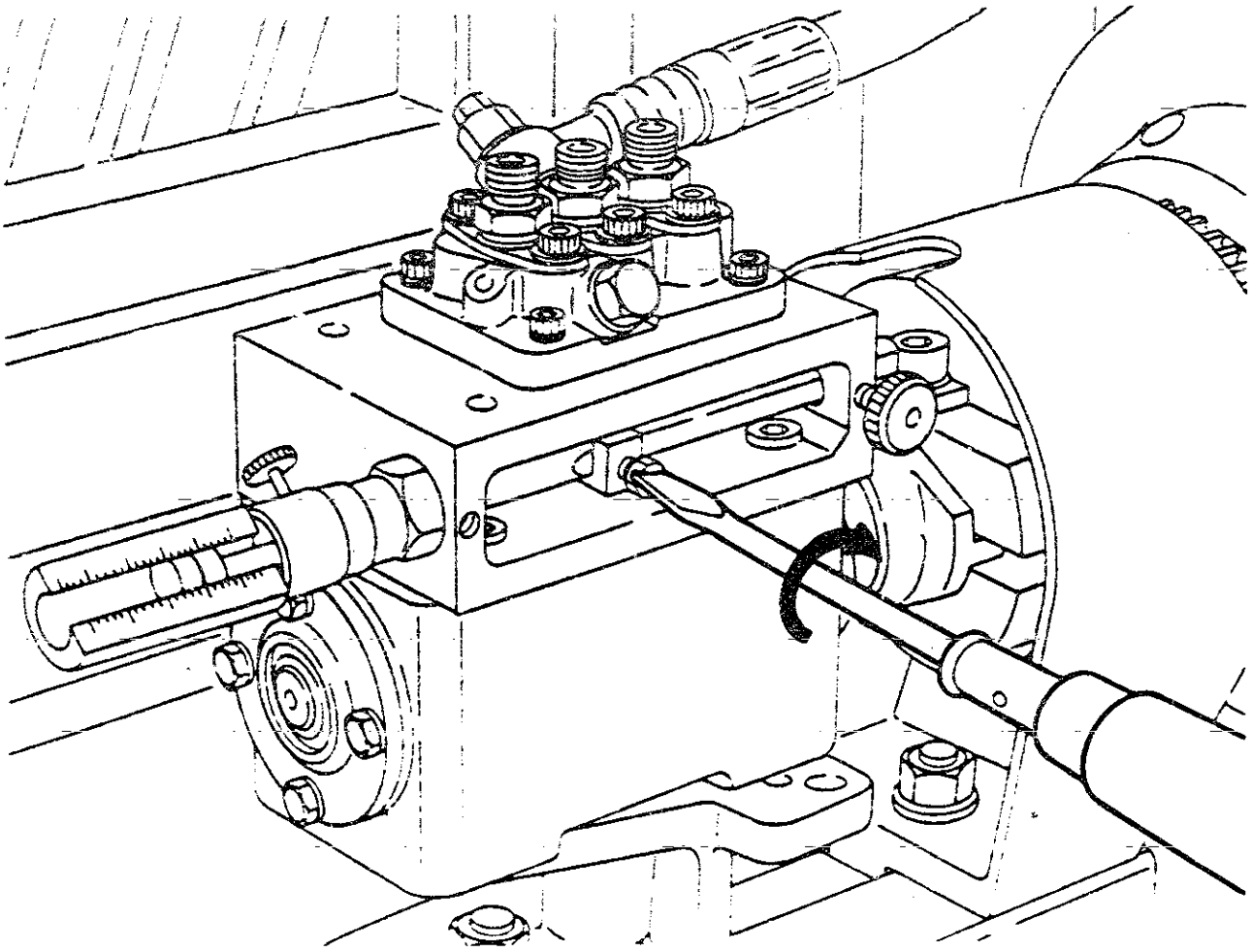

Fig. 93 Fixing control rod and guide

6. Fix the control rod and guide on the driving stand.

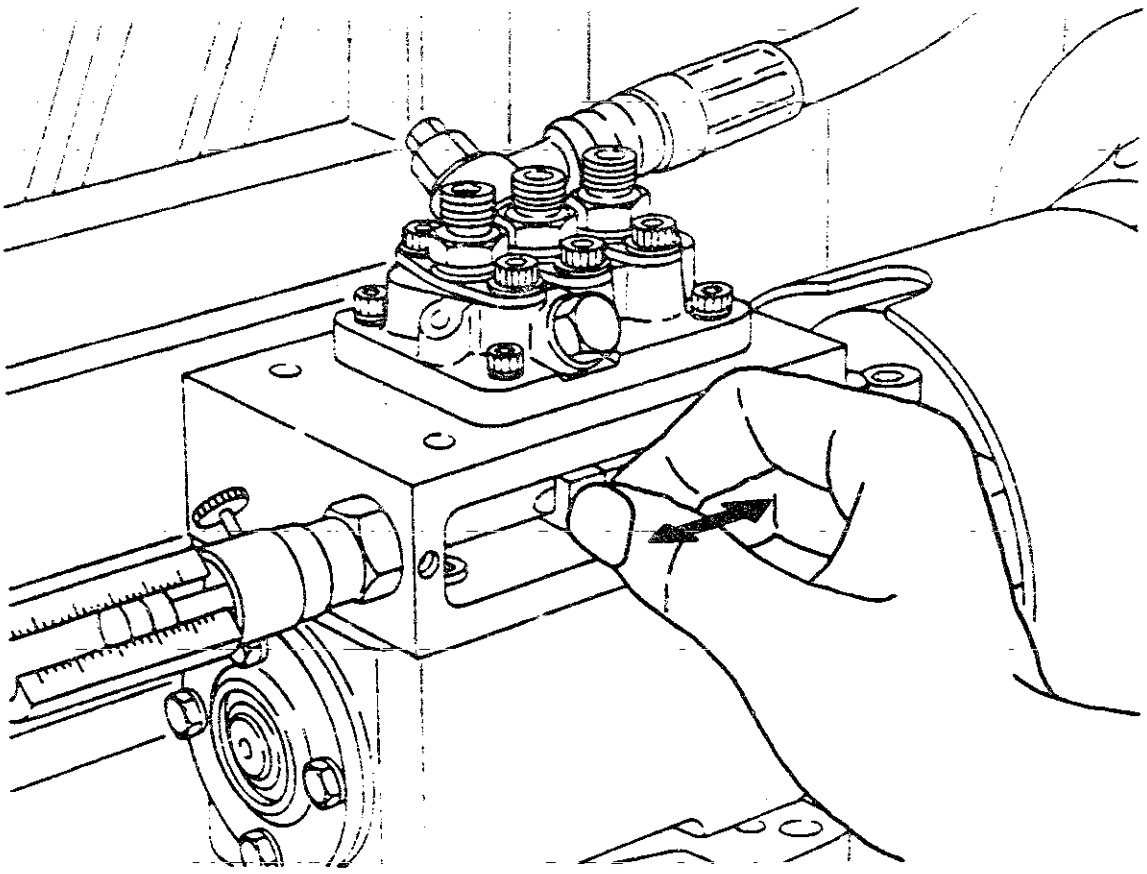

Fig. 94 Control rod "zero" point setting

7. With the control rod pressed fully to the "stop" direction, set the measuring device scale to "zero".

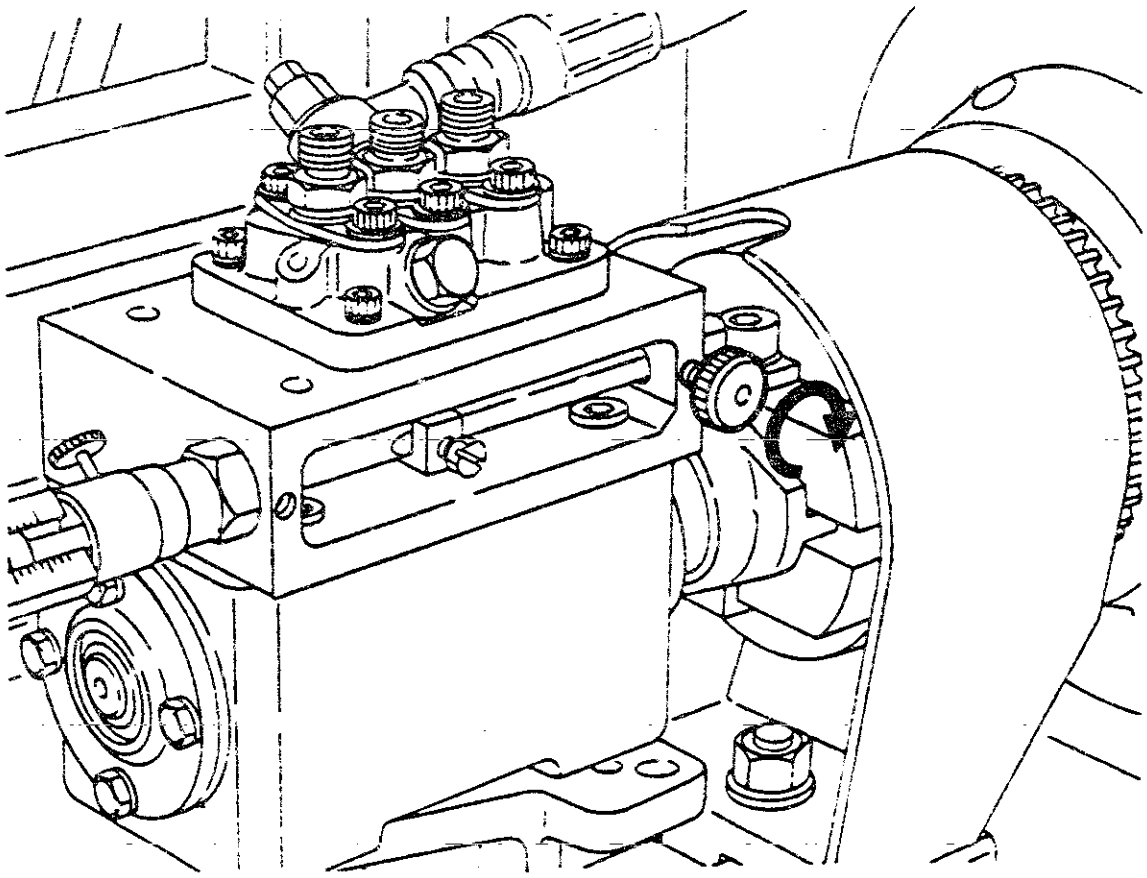

Fig. 95 Fixing control rod

Injection Timing Adjustment

1. Fix the control rod in the position specified as BASIC in the remarks column of the service data.

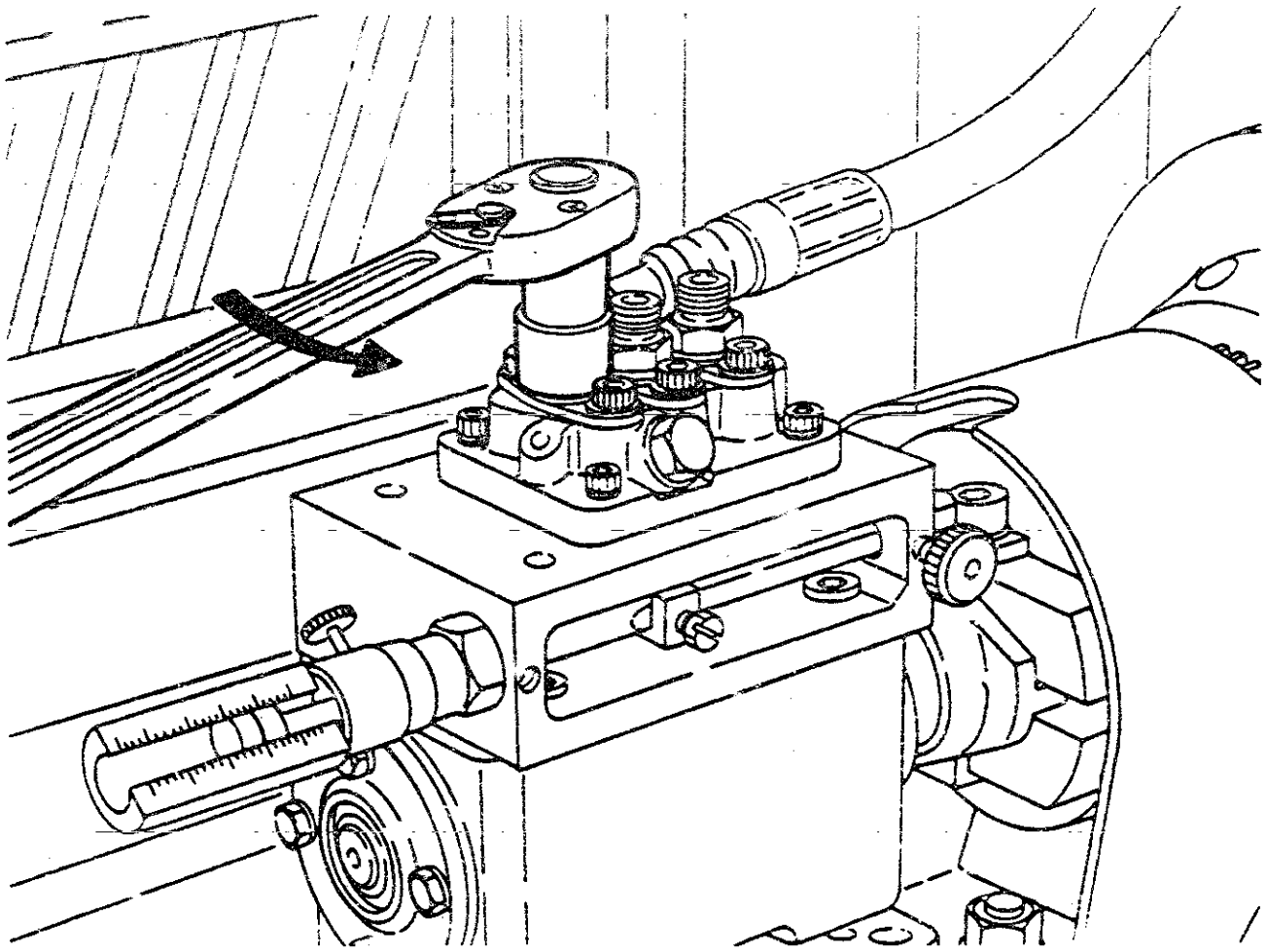

Fig. 96 Removing delivery valve holder

2. Remove the delivery valve holder.

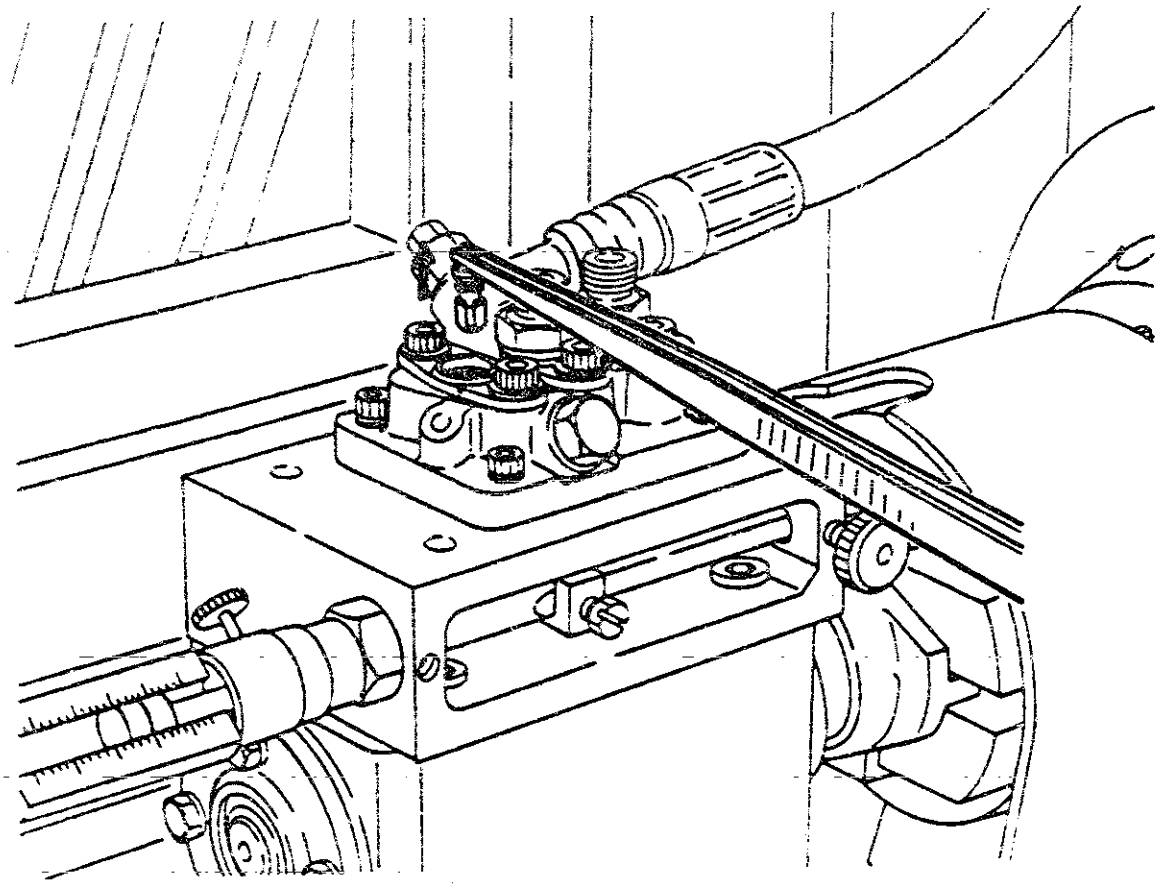

Fig. 97 Removing delivery valve

3. Remove the delivery valve spring and delivery valve.

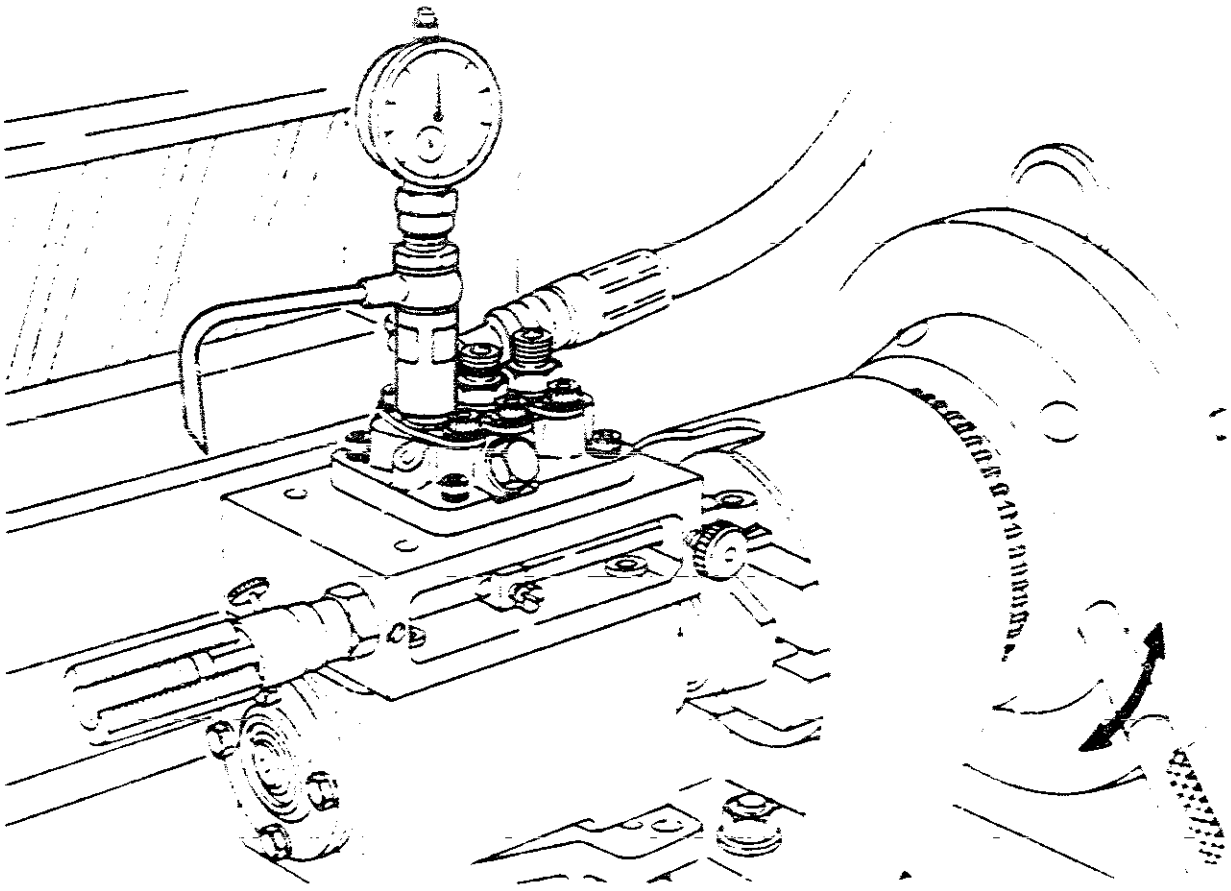

Fig. 98 Setting of "zero" point

4. After the measuring device (KDDC 0011) is attached to the injection pump, operate the pump test stand manually, and turn the driving stand cam shaft to set the cam of the cylinder to be measured to the bottom dead centre point. Then, set the dial gauge indicator to the zero point of the scale.

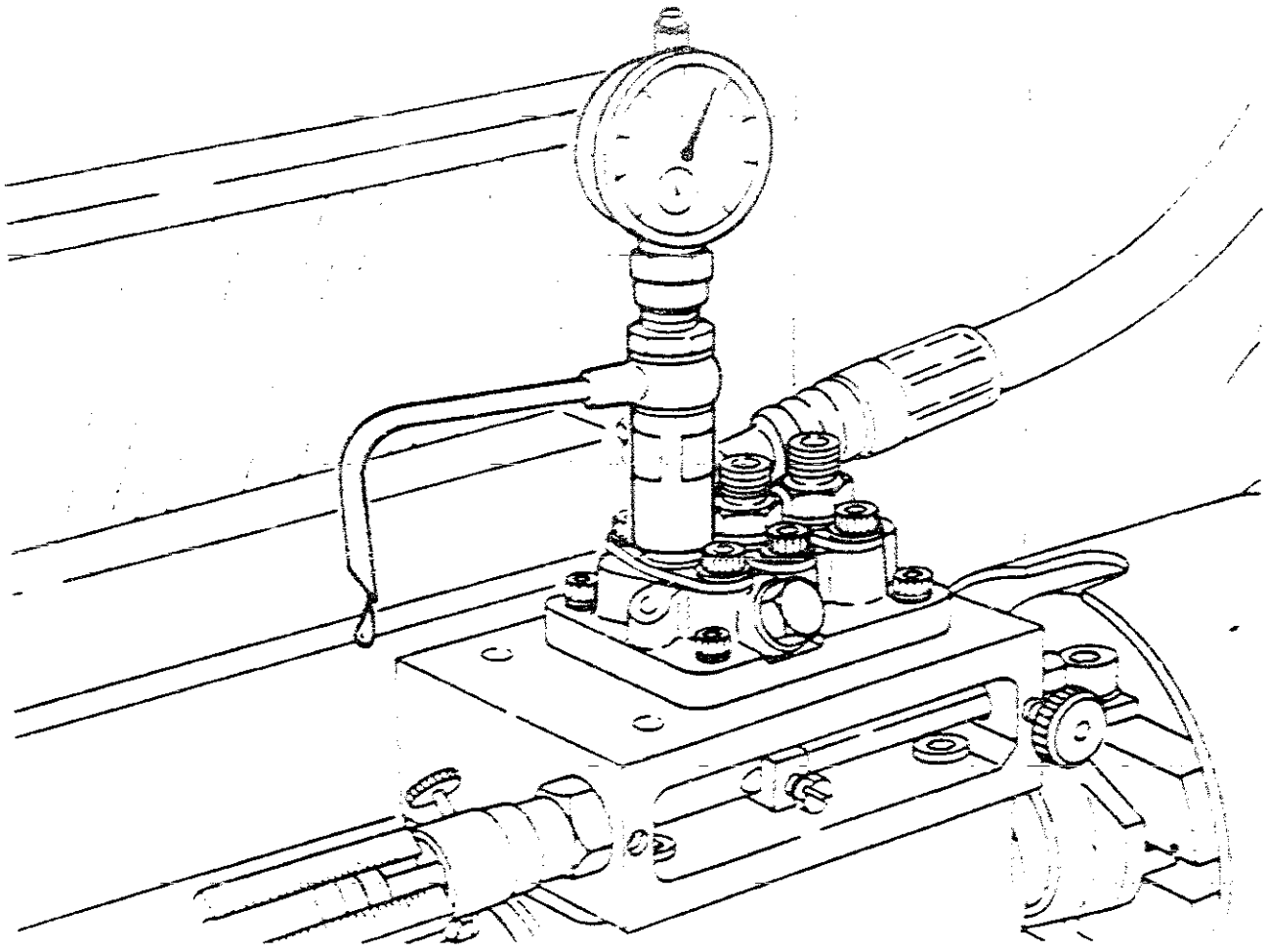

Fig. 99 Measuring plunger pre-stroke

5. Reduce the test fuel oil pressure as much as possible (e.g. 0.2 kg/cm^2), then feed fuel oil to the injection pump. At this time, the test fuel oil will flow out of the measuring device pipe, so the fuel oil must be caught in an oil pan.

Plate Type

Part Number *	Thickness(mm)	Stamping		Part Number *	Thickness(mm)	Stamping
140254-1400	1,80	80		140254-2200	2,20	20
-1500	1,85	85		-2300	2,25	25
-1600	1,90	90		-2400	2,30	30
-1700	1,95	95		-2500	2,35	35
-1800	2,00	00		-2600	2,40	40
-1900	2,05	05		-2700	2,45	45
-2000	2,10	10		-2800	2,50	50
-2100	2,15	15				

* Bosch Nr., see cross reference DKKC - Bosch, microfiche HB 30, HB 31.

6. Turn the cam shaft slowly by hand in a clockwise direction, viewed from the drive side. Read the value indicated by the dial gauge indicator when the test oil stops flowing out. If the value is not within the standard shown in the service data, adjust by changing the plate (53) thickness.

7. As above, attach the measuring device to each of the other cylinders, and measure the plunger pre-stroke.

8. After the measuring device is removed, attach the delivery valve, delivery valve spring and delivery valve holder. Tighten the delivery valve holder to the specified tightening torque.

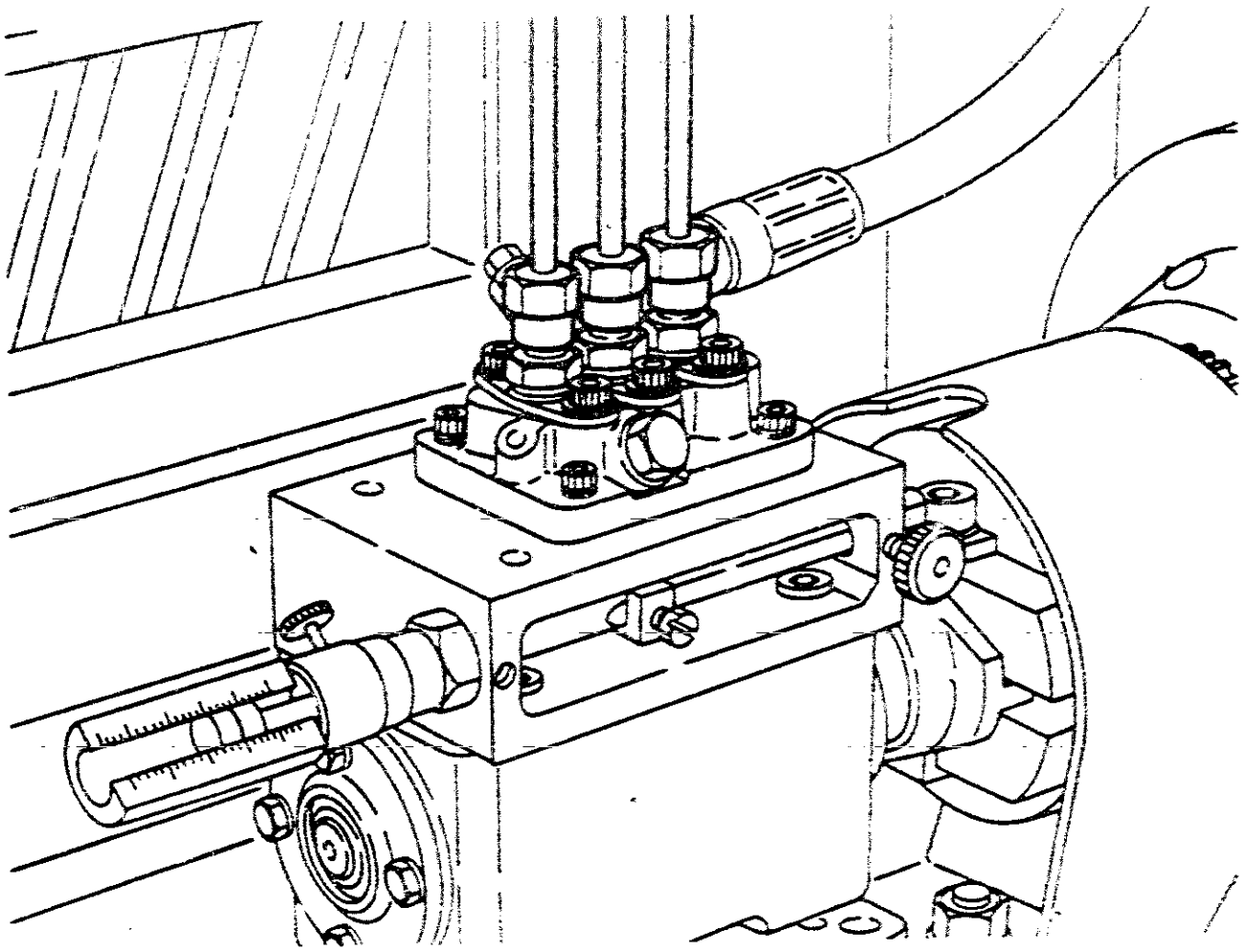

Fig. 100 Attaching injection pipe

Injection Quantity Adjustment

1. Attach the test nozzle holder (KDDC 0009) to the pump test stand and connect the injection pipe (1 680 750 014) to the delivery valve holder.

2. Fix the control rod in the positions specified in the service data.

3. Measure the injection quantities during the conditions specified in the service data.

Note: The direction of rotation of the driving stand cam shaft is clockwise when viewed from the drive side.

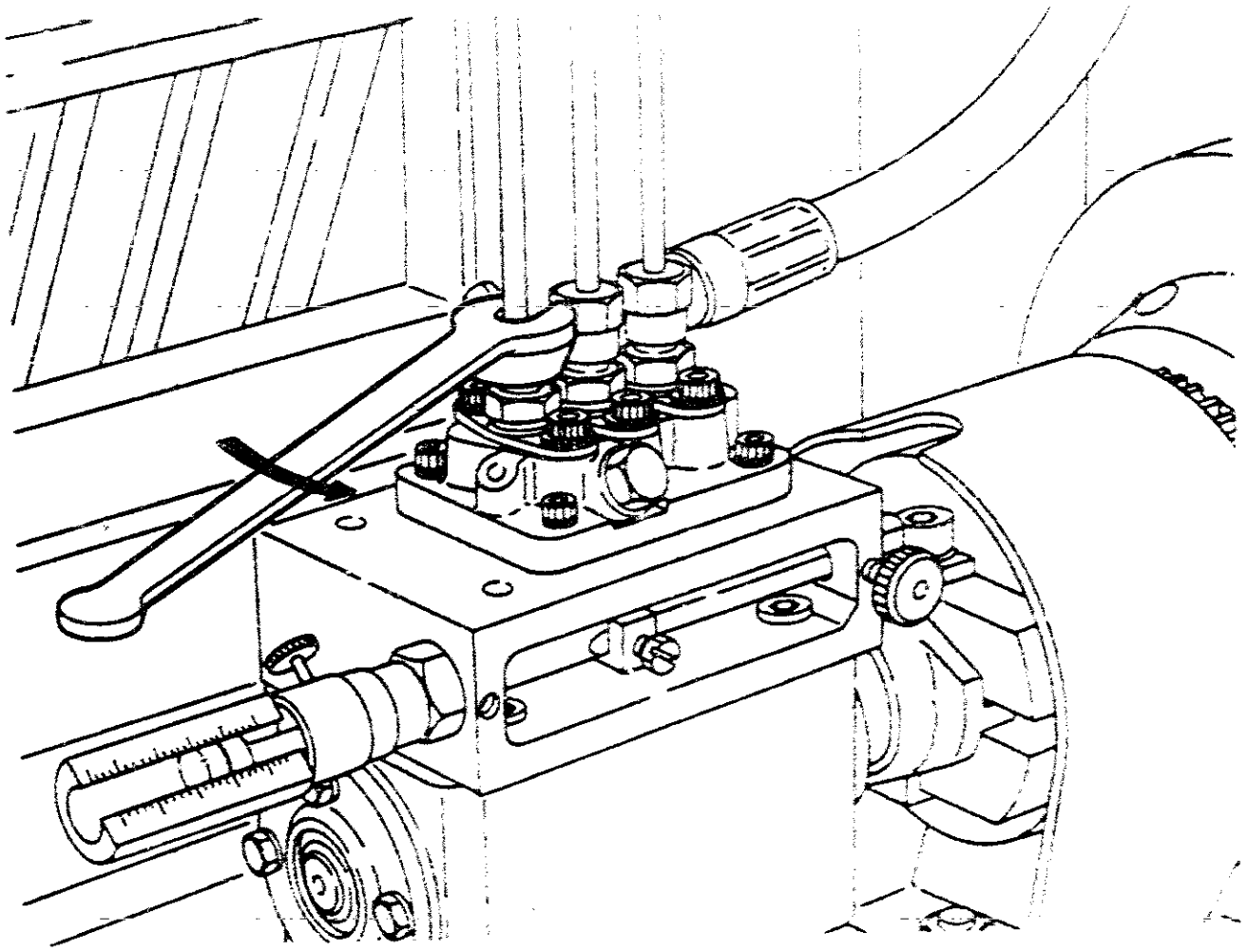

Fig. 101 Loosening injection pipe

4. If the injection quantity is not within the specified limits, adjust it in the following manner:

1) Loosen the injection pipe of the cylinder to be adjusted.

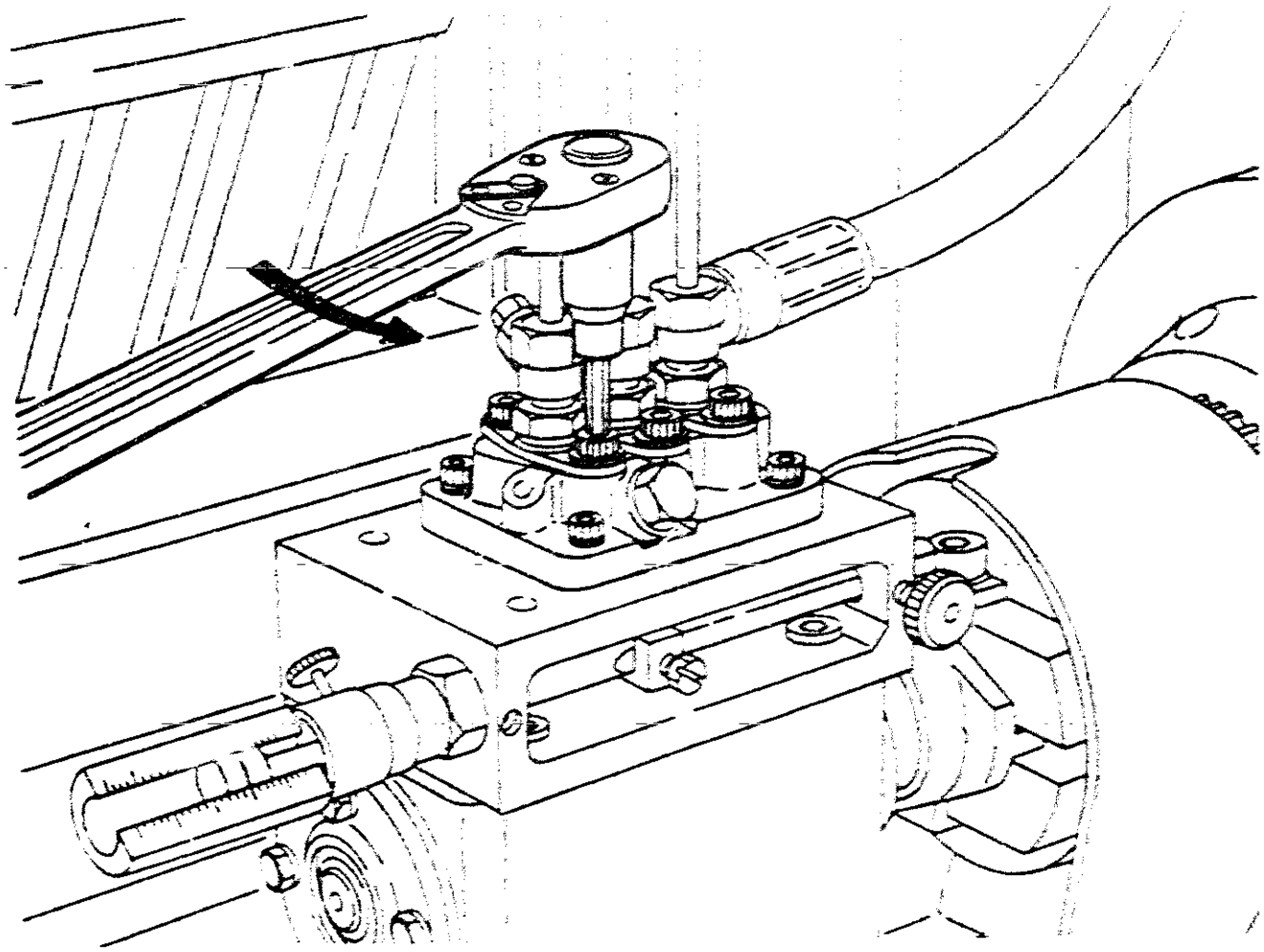

Fig. 102 Loosening socket head bolt

2) Loosen the socket head bolt (37) securing the sleeve flange (30).

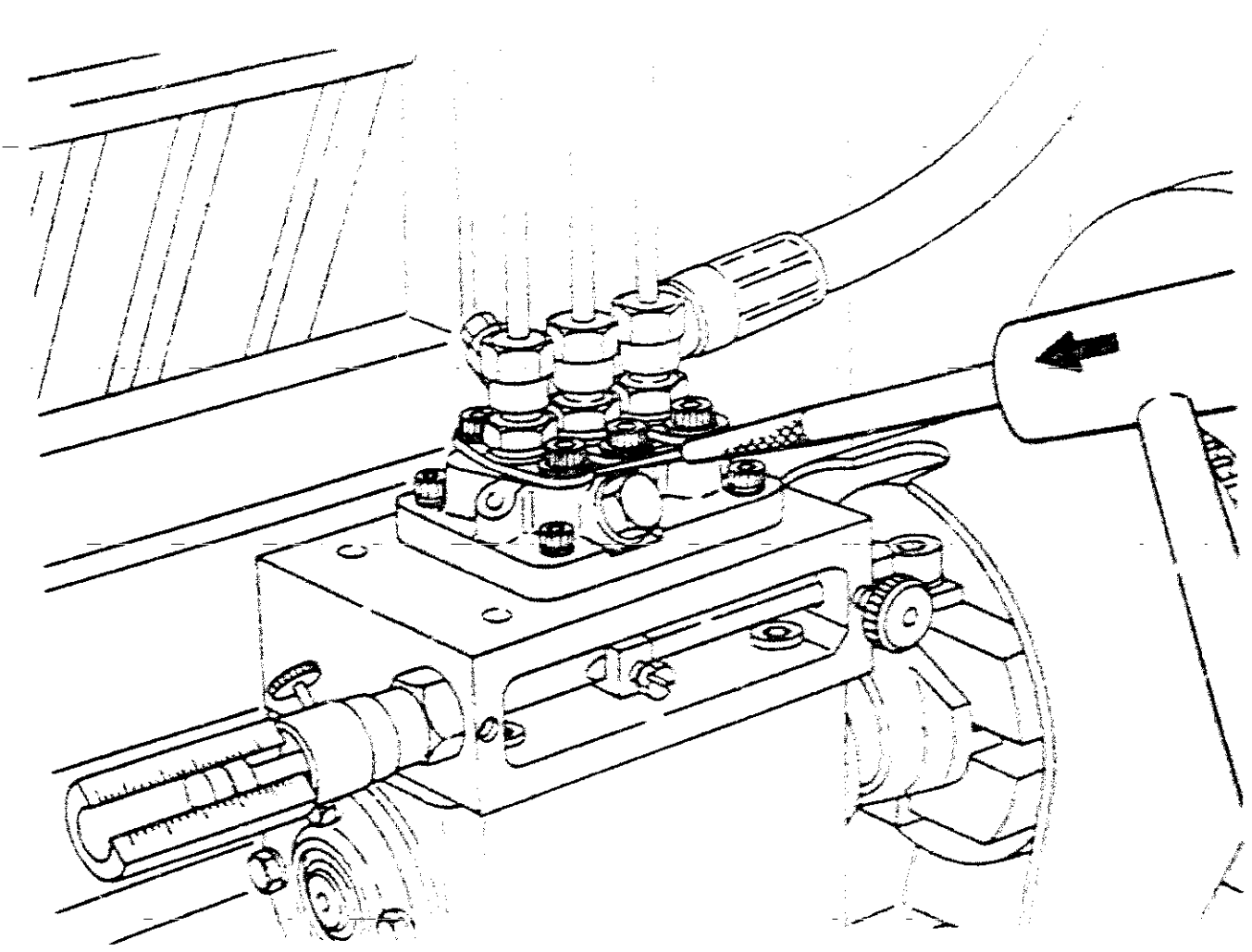

Fig. 103 Adjusting injection quantity

3) If the sleeve is lightly tapped and turned, the injection quantity varies as described below.

When the sleeve flange is turned clockwise as shown in Fig. 103:

Right helix plunger: The injection quantity increases.

Left helix plunger : The injection quantity decreases.

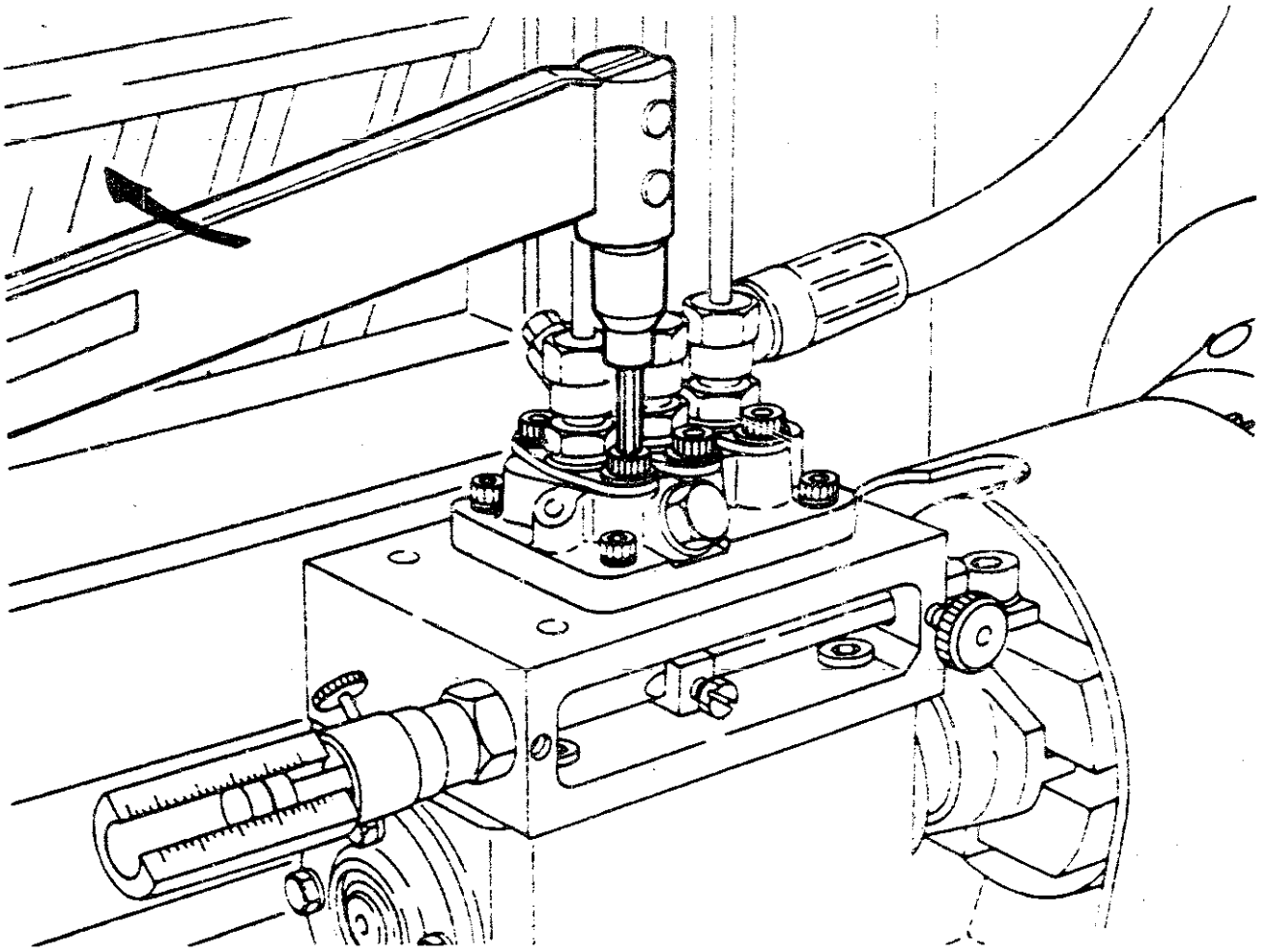

Fig. 104 Tightening socket head bolt

4) Tighten the socket head bolt to the specified torque, and measure the injection quantity again.

Specified tightening torque:

1 to 1.5 kg-m

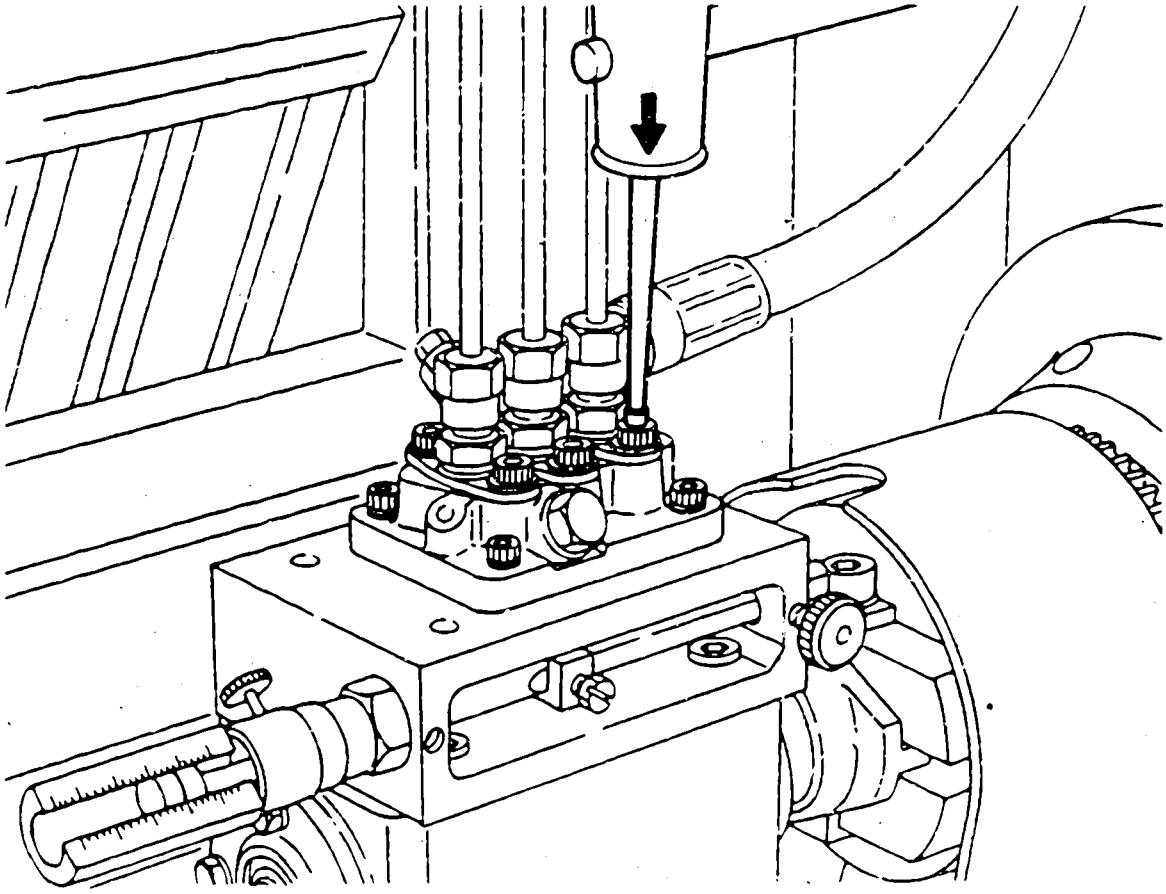

Bild 105 Stopfen eindrücken.

5) Stimmt die Fördermenge jedes Zylinders mit dem Standardwert überein, Plombierstopfen (152) in das Loch der Innensechskantschraube drücken.

Beachten:

Bei neueren Pumpenausführungen werden Zylinderschrauben mit sternförmigem Schlüsselaufnahmeloch verwendet, die keine Stopfen benötigen.

6) Nach dem Einstellen prüfen, ob jede Schraube mit dem vorgeschriebenem Anziehdrehmoment festgezogen ist (siehe Bild 107).

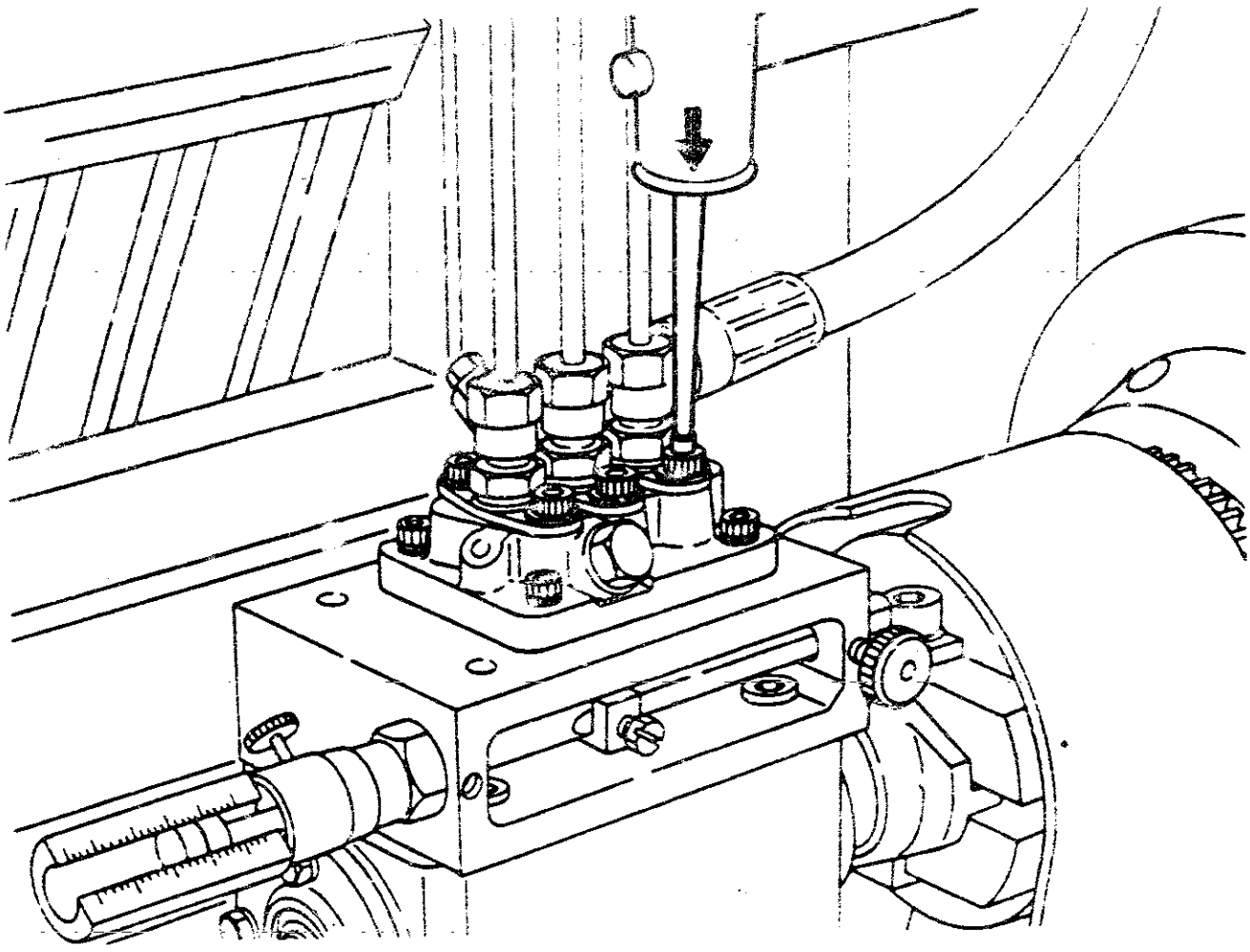

Fig. 105 Inserting plug

5) When the injection quantity of each cylinder matches the standard value, insert the plug (152) into the hole of the socket head bolt for sealing.

Note: Later model pumps use star shaped socket head bolts which do not need plugs.

6) After adjustment is complete, check that each screw is tightened to the specified torque. (See Fig. 107.)

Handling

The injection pump is a precision instrument and it plays an important role as the heart of the engine, so do not disassemble the injection pump unnecessarily.

If engine functions deteriorate or starting cannot be performed, refer to the engine work shop manual. Remove the injection pump from the engine and disassemble only when the trouble is directly attributed to the injection pump.

Sealing Position

Injection quantity adjusting points are sealed with lead.

Do not perform disassembly and readjustment without the pump test stand.

Removing Pump

Following the engine work shop manual, remove the injection pump from the engine. At this time, fix the control lever of the governer in the designated position, and then remove the link connection between the injection pump control rack (or rod) and governer.

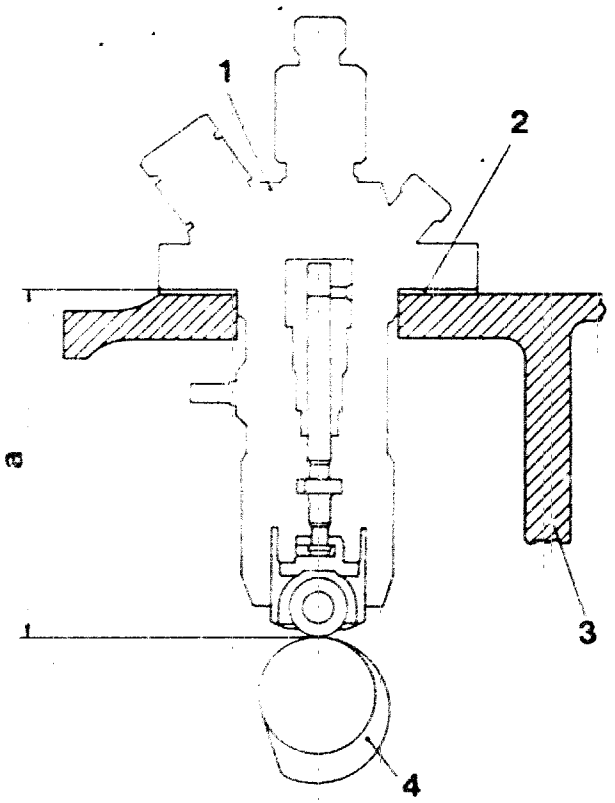

Fig. 106 Mounting injection pump on engine

1 = Injection pump
2 = Adjusting shim(s)
3 = Cylinder body
4 = No. 1 cylinder cam

a = Distance L

Mounting Pump

Turn the injection pump drive cam shaft and place the No. 1 cam in the bottom dead center position. Measure the distance from the cam surface to the injection pump set surface and adjust the distance using the adjusting shim (supplied by the engine manufacturer) to obtain the following set values. (Fig. 106)

Einspritzpumpe einbauen (Fortsetzung)

Einspritzpumpe Typ PFR-KD: L = 76 ± 0,05 mm

Einspritzpumpe Typ PFR-MD: L = 66 ± 0,05 mm

Ist das Maß L zu klein, stößt der Pumpenkolben oben im Pumpenzylinder an und beschädigt ihn.

Ist das Maß L zu groß, hebt der Rollenstößel im unteren Totpunkt vom Nocken ab, so daß der Führungsstift des Rollenstößels beschädigt wird.

PFR·KD type pump: L=76±0.05mm

PFR·MD type pump: L=66±0.05mm

If dimension L is too small, the plunger will hit the plunger barrel resulting in damage.

If dimension L is too large, the tappet roller will not contact the cam when the cam is at the bottom dead center point resulting in damage to the tappet guide pin.

CODE NUMBER

For PFR·KD pump

1 0 4 2 9 8 – 4 0 1 0
(1) (2) (3) (4) (5)

(1) PFR·KD injection pump

(2) Plunger diameter (mm)
3: ϕ5 6: ϕ6.5
4: ϕ5.5 7: ϕ7
5: ϕ6 8: ϕ7.5

(3) Number of cylinders
1: 1 cylinder
2: 2 cylinders
3: 3 cylinders
4: 4 cylinders
5: 5 cylinders

(4) Specific number

(5) Modification code

For PFR·MD pump

1 0 4 2 0 5 – 3 0 1 0
(1) (2) (3) (4) (5)

(1) PFR·MD injection pump

(2) Plunger diameter (mm)
3: ϕ4 6: ϕ5.5
4: ϕ4.5 7: ϕ6
5: ϕ5

(3) Number of cylinders
1: 1 cylinder
2: 2 cylinders
3: 3 cylinders
4: 4 cylinders

(4) Specific number

(5) Modification code

BOSCH Type Number

N P	–	P	F	R	4	K D	7 5	/ 2	N P	6
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

(1) Manufactured by DIESEL KIKI CO., LTD.
(2) Injection pump
(3) The cam shaft is not included in the injection pump.
(4) Tappet(s) included in the injection pump.
(5) Number of cylinders.
(6) Size (KD, MD etc.)
(7) Plunger diameter (mm) × 10
(8) Helix
/1: Left helix plunger
/2: Right helix plunger
(9) Mass produced parts (Normal part No.)
(10) Modification code

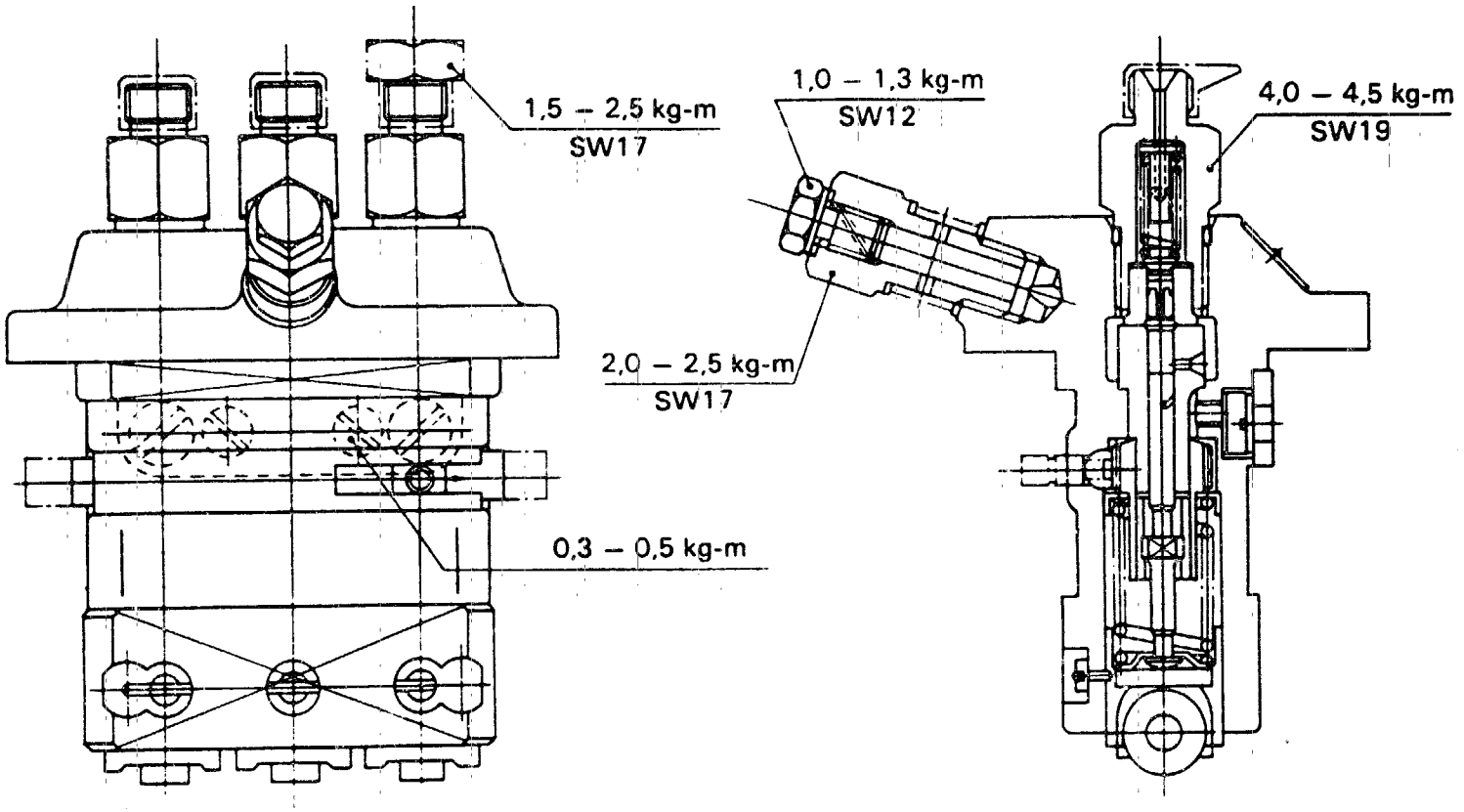

Fig. 107

TIGHTENING TORQUES

Note: SW 19 means that the width across flats of a bolt is 19mm.

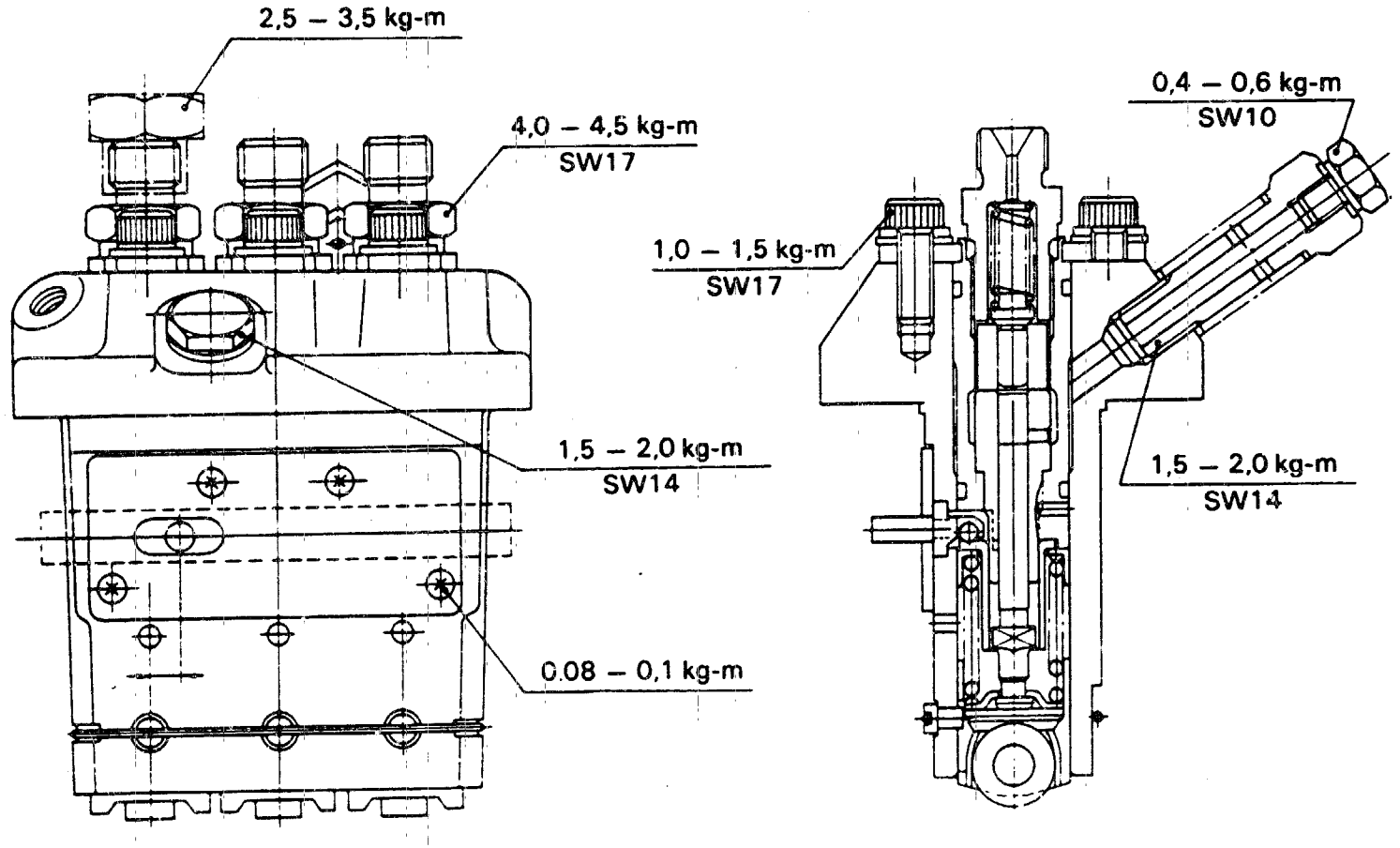

Fig. 107-1

Tightening torques

Note: SW 19 means that the width across flats of a bolt is 19 mm.

C O N T E N T S